

TESIS DOCTORAL

PROGRAMA DE DOCTORADO EN MEDICINA CLÍNICA Y SALUD PÚBLICA

EFFECTOS DE UN PROGRAMA DE INDUCCIÓN MIOFASCIAL EN PACIENTES ONCOLÓGICOS

DISEÑO CRUZADO, ALEATORIZADO,
SIMPLE CIEGO Y CONTROLADO CON PLACEBO

EDUARDO CASTRO MARTÍN

UGR 2022

DIRECTORES

NOELIA GALIANO CASTILLO

MANUEL ARROYO MORALES



EFFECTOS DE UN PROGRAMA DE INDUCCIÓN MIOFASCIAL EN PACIENTES ONCOLÓGICOS

DISEÑO CRUZADO, ALEATORIZADO,
SIMPLE CIEGO Y CONTROLADO CON PLACEBO

T E S I S D O C T O R A L

EFFECTOS DE UN PROGRAMA DE INDUCCIÓN MIOFASCIAL EN PACIENTES ONCOLÓGICOS

DISEÑO CRUZADO, ALEATORIZADO,
SIMPLE CIEGO Y CONTROLADO CON PLACEBO



PROGRAMA DE DOCTORADO EN MEDICINA CLÍNICA Y SALUD PÚBLICA

Departamento de Fisioterapia

[Facultad de Ciencias de la Salud - Universidad de Granada]

EDUARDO CASTRO MARTÍN

2022

DIRECTORES

NOELIA GALIANO CASTILLO

MANUEL ARROYO MORALES

Editor: Universidad de Granada. Tesis Doctorales
Autor: Eduardo Castro Martín
ISBN: 978-84-1117-641-5
URI: <https://hdl.handle.net/10481/79627>

IMAGEN DE PORTADA Tejido fascial (fotografía de Andrzej Pilat)
DISEÑO Y MAQUETACIÓN Virginia Vílchez Lomas | viriniavl@afoot.es
IMPRESIÓN Antonio Maldonado, Impresión Ideal, Granada

OCTUBRE 2022

A mi familia, sois lo más importante.

“La ciencia será siempre una búsqueda,
jamás un descubrimiento real.
Es un viaje, nunca una llegada”

(Karl Raimund Popper)

TABLA DE CONTENIDO

XIII	Resumen / Abstract
XVII	Abreviaturas
1	INTRODUCCIÓN
4	¿Qué es movimiento?
5	De la cognición a la acción
6	Fascia y movimiento
9	Disfunción fascial
10	Inducción Miofascial
13	Unwinding Miofascial
16	Secuelas y disfunciones en pacientes oncológicos
17	Secuelas y disfunciones en cáncer de mama
18	Secuelas y disfunciones en cáncer de cabeza y cuello
33	OBJETIVOS
37	MATERIAL Y MÉTODOS, RESULTADOS, DISCUSIÓN
41	Estudio I Myofascial Induction Effects on Neck-Shoulder Pain in Breast Cancer Survivors: Randomized, Single-Blind, Placebo-Controlled Crossover Design.
61	Estudio II Effects of a Single Myofascial Induction Session on Neural Mechanosensitivity in Breast Cancer Survivors: A Secondary Analysis of a Crossover Study.
79	Estudio III Myofascial Induction Therapy Improves the Sequelae of Medical Treatment in Head and Neck Cancer Survivors: A Single-Blind, Placebo-Controlled, Randomized Cross-Over Study.
97	LIMITACIONES Y FORTALEZAS
101	FUTURAS LÍNEAS DE INVESTIGACIÓN
105	CONCLUSIONES
109	ANEXOS
111	Artículos derivados de la Tesis Doctoral
119	Curriculum Vitae corto
125	AGRADECIMIENTOS
131	Notas

RESUMEN

La Fisioterapia, en la actualidad, se aleja de la discapacidad para centrar su ámbito de aplicación en la salud. Desde un marco biopsicosocial, el fisioterapeuta profundiza en todos los aspectos físicos, ambientales, fisiológicos, psicológicos, económicos y sociales del movimiento, para utilizarlo como recurso terapéutico en la promoción, educación y recuperación de la función (salud).

El movimiento es la expresión funcional de la persona tras la que subyacen procesos complejos de orden neuromusculoesqueléticos, neurocognitivos y emocionales. Lograrlo depende de la capacidad de mantener un organismo en perfecta sintonía, en un exitoso grado de adaptabilidad a las demandas internas y externas (alostasis, homeostasis) y de un perfecto nivel de comunicación. El sistema fascial se muestra como un sustrato indispensable para cumplir con estas exigencias y dotar al organismo de la continuidad y unidad corporal, a la vez que aporta el más alto grado de información al sistema nervioso, para que pueda operar de la manera más eficiente y eficaz. La fascia, el gran tejido olvidado, está siendo objeto de profundas investigaciones en los últimos veinte años, identificándose el papel crucial que desarrolla en el procesamiento del movimiento. La ciencia nos muestra ahora, cómo se altera y lesiona, y cómo abordarlo para recuperar sus capacidades. La Terapia Manual, como recurso primario de la Fisioterapia, y en concreto la Inducción Miofascial (IM) son herramientas eficaces del fisioterapeuta para intervenir en el sistema fascial, y de este modo actuar en la prevención, el mantenimiento, la adaptación y

ABSTRACT

Nowadays, Physiotherapy, is moving away from disability to focus its scope of application on health. From a biopsychosocial framework, the physiotherapist delves into all the physical, environmental, physiological, psychological, economic and social aspects of movement, to use it as a therapeutic resource in the promotion, education and recovery of function (health).

Movement is the functional expression of the person underlying complex neuromusculoskeletal, neurocognitive and emotional processes. Achieving it depends on the ability to maintain an organism in perfect harmony, in a successful degree of adaptability to internal and external demands (allostasis, homeostasis) and a perfect level of communication. The fascial system is shown as an indispensable substrate to find these demands and provide the organism with continuity and body unity, while providing the highest degree of information to the nervous system, so that it can operate in the most efficient and effective way. The fascia, the great forgotten tissue, has been the subject of in-depth research in the last twenty years, identifying the crucial role it plays in the processing of movement. Science now shows us how it is altered and injured, and how to approach it in order to recover its capabilities. Manual Therapy, as a primary resource of Physiotherapy, and specifically Myofascial Induction (MI) are effective tools of the physiotherapist to intervene in the fascial system, and thus act in the prevention, maintenance, adaptation and recovery of movement (function). Within the MI procedures, Myofascial Unwinding (MU) maneuvers are particularly coherent with the construction

la recuperación del movimiento (función). Dentro de los procedimientos de IM las maniobras de *Unwinding Miofascial* (UM) se muestran especialmente coherentes con la construcción de la ya mencionada dinámica corporal. A través de un estímulo manual, se facilita una secuencia técnica que contiene aspectos corticales y angulares del movimiento, involucrando plenamente al paciente. Esta forma de trabajo en Fisioterapia es novedosa y aún cuenta con escasa investigación. La literatura científica prescribe su uso para la recuperación de problemas neuro-ortopédicos, postraumáticos y degenerativos. Entre estos, identificamos los efectos secundarios que sufren los pacientes tras el tratamiento oncológico. Los procedimientos médicos cada vez son más exitosos, pero inevitablemente surgen numerosas secuelas que restan calidad de vida. Las hemos identificado en los supervivientes de cáncer de mama (CM) y cáncer de cabeza y cuello (CCC) y hemos planteado su tratamiento con IM (a través del procedemineto UM).

Por lo tanto, los objetivos de la presente Tesis Doctoral fueron: Investigar los efectos inmediatos de la IM (frente a placebo de onda corta como control) sobre el dolor percibido, el rango de movimiento cervical y del hombro, y el estado de ánimo en supervivientes de CM con morbilidad de hombro/brazo. Como objetivo secundario examinamos las relaciones entre las modificaciones del dolor y el rango de movimiento cervical y del hombro en el lado afectado por el CM (**estudio I**). Analizar los efectos a corto plazo de una sola sesión de IM sobre la mecanosensibilidad neuronal a través del rango de movimiento, la reproducción de los síntomas y los umbrales de dolor por presión, y test neurodinámicos del miembro superior en comparación con un placebo control. Como

of the mentioned body dynamics. Through a manual stimulus, a technical sequence containing cortical and angular aspects of movement is facilitated, fully involving the patient. This is a new way of working in Physiotherapy and that is why still has little research. The scientific literature prescribes its use for the recovery of neuro-orthopedic, post-traumatic and degenerative problems. Among these, we identify the side effects suffered by patients after cancer treatment. Medical procedures are increasingly successful, but inevitably numerous sequelae arise that detract from quality of life. We have identified them in breast cancer (BC) and head and neck cancer (HNC) survivors and have proposed their treatment with IM (through the MU procedure).

Therefore, the objectives of the present dissertation were: To investigate the immediate effects of MI (vs. shortwave placebo as a control) on perceived pain, cervical and shoulder range of motion, and mood in CM survivors with shoulder/arm morbidity. As a secondary objective we examined the relationships between pain modifications and cervical and shoulder range of motion on the CM-affected side (study I). To analyze the short-term effects of a single session of MI on neural mechanosensitivity through range of motion, symptom reproduction and pressure pain thresholds, and upper limb neurodynamic testing compared to a placebo control. As a secondary objective, to determine the possible influence or not of patient attitudes towards massage in CM survivors (study II). Finally, to determine the immediate effects of MI compared to a placebo control on cervical and shoulder pain, cervical and shoulder range of motion, maximum mouth opening and cervical muscle function in CCC survivors with neck/shoulder morbidity (study III).

objetivo secundario, determinar la posible influencia o no de las actitudes del paciente hacia el masaje en supervivientes de CM (**estudio II**). Por último, determinar los efectos inmediatos de IM en comparación con un placebo control sobre el dolor cervical y de hombro, el rango de movimiento cervical y del hombro, la apertura máxima de la boca y la función muscular cervical en supervivientes de CCC con morbilidad de cuello/hombro (**estudio III**).

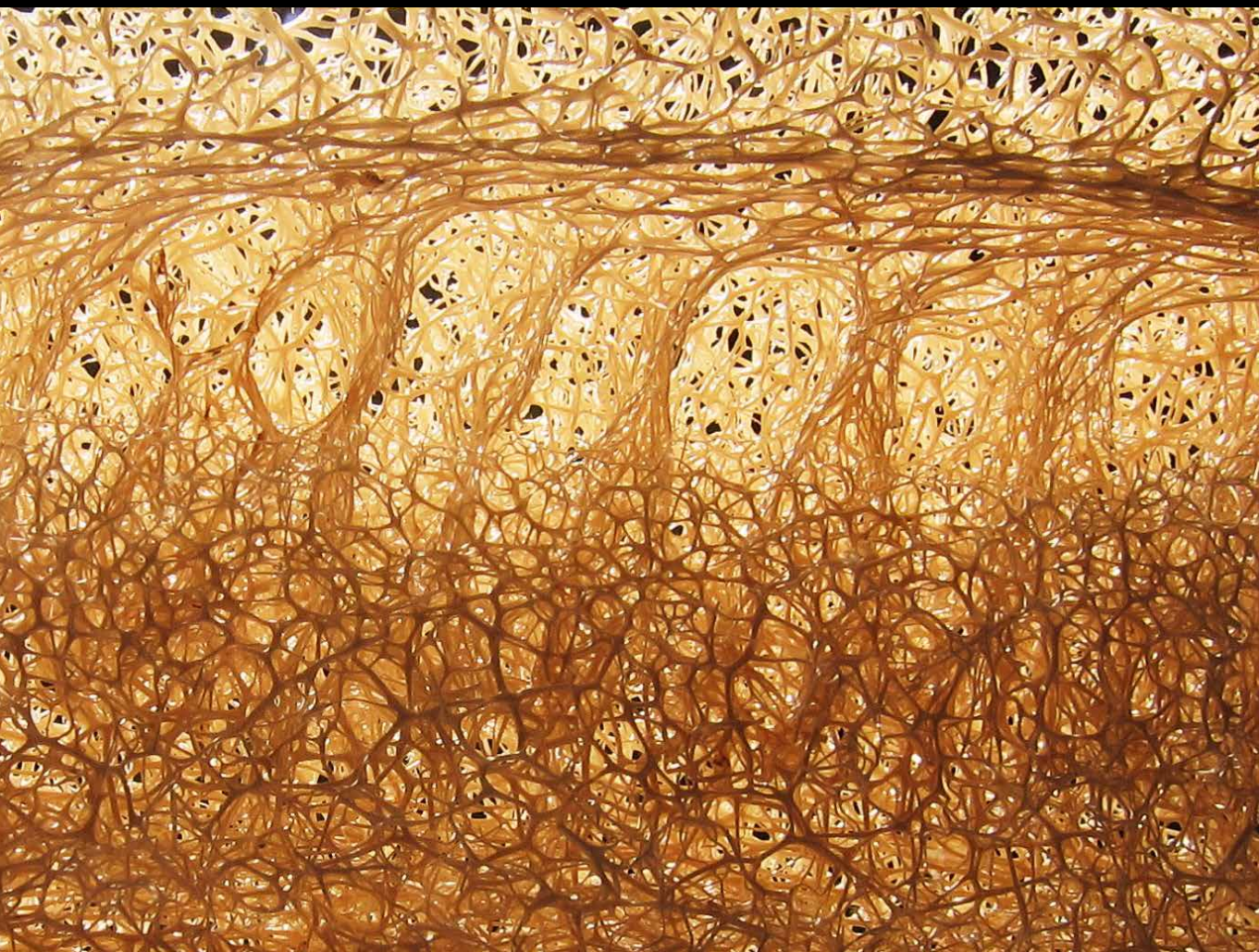
Los resultados de la Tesis Doctoral aportan evidencia científica que apoya el uso de un novedoso programa de tratamiento en Fisioterapia a través de IM para la recuperación y mejora de los procesos dolorosos y trastornos del movimiento como secuelas presentes en supervivientes de CM y CCC. Por último, estos resultados mejoran nuestro conocimiento sobre la influencia de la IM y en concreto de UM, en la recuperación funcional de estos pacientes planteando la necesidad de su tratamiento a través de la Fisioterapia y la Terapia Manual como parte del equipo multidisciplinar de rehabilitación oncológica.

The results of the Doctoral Thesis provide scientific evidence supporting the use of a novel treatment program in Physiotherapy through MI for the recovery and improvement of painful processes and movement disorders as sequelae present in CM and CCC survivors. Finally, these results improve our knowledge about the influence of MI, and specifically MU, in the functional recovery of these patients, raising the need for its treatment through Physiotherapy and Manual Therapy as part of the multidisciplinary oncological rehabilitation team.

ABREVIATURAS

APTA	American Physical Therapy Association
CCC	Cáncer de Cabeza y Cuello
CM	Cáncer de Mama
FTL	Fascia Toraco Lumbar
IM	Inducción Miofascial
MEC	Matriz Extra Celular
TGF β -1	Factor de Crecimiento Transformante Beta
TM	Terapia Manual
TNF	Factor de Necrosis Tumoral
UM	Unwinding Miofascial

INTRODUCCIÓN





En la actualidad, la Fisioterapia vive inmersa en un periodo de revisión en relación a su papel social y sobre la salud. Una disciplina que surgió desde la aplicación de medios físicos (el agua y el masaje esencialmente) de la mano de civilizaciones como la mesopotámica o la egipcia (Cardona, 2013) para finalmente consolidarse en la edad moderna de la mano de Henrik Ling (con el ejercicio terapéutico y la terapia manual) redactando su obra “Principios Generales de la Gimnasia” y desarrollando a su vez la práctica y enseñanza del llamado “Masaje Sueco” (Cameron, 2009).

La fisioterapia conceptualmente se centró en el tratamiento y la rehabilitación de pacientes con alteraciones motoras, sin embargo, contemporáneamente evoluciona hacia la práctica centrada en la salud, en vez del enfoque en la discapacidad (Dean et al. 2014). Esta evolución apunta, sobre todo, a intervenciones de gran alcance que involucren el cuerpo humano, el ambiente social y las políticas públicas en la búsqueda de la mejora de la independencia, la funcionalidad y la promoción de la salud y el bienestar.

En relación a la práctica, las herramientas básicas han sido los medios físicos, especialmente el ejercicio terapéutico, la terapia manual, el uso del agua y los agentes de electroterapia (Gilbert y Carnot, 1921; OMS, 2021). En los últimos años y tras la pandemia (Covid 19) ha ocurrido un ascenso pujante de las sesiones de “telerehabilitación” (on-line) apostando por el ejercicio terapéutico de forma muy sólida y por la educación en la neurobiología del dolor (Bonatesta et al. 2022; Fioratti et al. 2022). Junto a estos usos, las intervenciones con realidad virtual, con métodos de representación del movimiento y los abordajes ecoguiados se presentan también como una opción en auge (La Touche, 2020; Dolbow et al. 2021).

En cualquier caso, la prioridad del fisioterapeuta, tanto en el origen, como en el pasado, en el presente o en el futuro, será enfocar a la prevención, el mantenimiento, la adaptación y la recuperación del movimiento (función).

La World Confederation for Physical Therapy afirma que:

“La fisioterapia es un servicio que prestan los fisioterapeutas a las personas y poblaciones para desarrollar, mantener y restablecer el máximo movimiento y capacidad funcional a lo largo de la vida. El servicio se presta en circunstancias en que el movimiento y la función se ven afectados por el envejecimiento, las lesiones, el dolor, las enfermedades, los trastornos, las afecciones y/o los factores ambientales, entendiendo que el movimiento funcional es fundamental para lo que significa estar sano”.

Hay que destacar que el movimiento no es exclusividad del fisioterapeuta. Otros profesionales desde la Medicina, la Educación Física, la Terapia Ocupacional y la Fonoaudiología, también lo utilizan. Pero la forma en que la Fisioterapia lo comprende, articulando el movimiento con el cuerpo y su interacción, permitiéndole una mirada integral y holística, es la perspectiva que nos diferencia (Broberg et al. 2003).

La fisioterapia profundiza en todos los aspectos físicos, ambientales, fisiológicos, psicológicos, económicos y sociales del movimiento, para utilizarlo como recurso terapéutico en la promoción, educación y recuperación de la función (salud).

La teoría del movimiento continuo (Cott, 1995) es un modelo conceptual que sustenta esta cuestión. En esta teoría el movimiento se considera en los siguientes niveles: la molécula, la célula, el tejido, el órgano, las partes del cuerpo,

el cuerpo, la persona en el ambiente y la persona en la sociedad. Surge una idea de “continuo” que presupone que la influencia de un nivel puede afectar el movimiento del otro nivel, desde lo micro a lo macro y en sentido inverso. Así, la fisioterapia debe considerar las dimensiones individuales y corporales, pero no quedar restringida a éstas, debe también contemplar las dimensiones psicosociales y colectivas, en contextos físicos y sociales más amplios (Bispo, 2021).

La American Physical Therapy Association (APTA 2019) habla de un *sistema de movimiento* para el fisioterapeuta de la misma forma que un inmunólogo trabaja con el *sistema inmunológico* o un cardiólogo lo hace con el *sistema cardíaco*:

“La profesión del fisioterapeuta definirá y promoverá el sistema de movimiento como base para optimizar el movimiento. El reconocimiento y validación del sistema de movimiento es esencial para comprender completamente la función fisiológica y el potencial del cuerpo humano. La profesión será responsable de monitorear el sistema de movimiento de un individuo a lo largo de su vida para promover un desarrollo óptimo, diagnosticar disfunciones y brindar intervenciones dirigidas a prevenir o mejorar las restricciones a la actividad y la participación”. El sistema de movimiento formará la base de la práctica, la educación y la investigación de la profesión.

¿QUÉ ES MOVIMIENTO?

Sahrmann (2017) define el movimiento como “un sistema de sistemas de órganos fisiológicos (pulmonar, cardiovascular, endocrino, musculoesquelético, nervioso y tegumentario) que interactúan para producir el movimiento

del cuerpo y sus partes” (Sahrmann, 2017). El movimiento involucra los cambios metabólicos, incrementos estructurales, cambios morfofuncionales, la maduración, dimensiones físicas, actividad motriz, cognitiva, psicológica, afectiva y social (APTA 2015).

El movimiento es la clave para una vida óptima y con calidad, que se extiende más allá de la salud mostrando la capacidad de cada persona para participar y contribuir en la sociedad. Movimiento es la expresión funcional de la persona.

“Nada es más importante que el movimiento cuando se considera en todos los niveles del organismo, desde los iones que atraviesan las membranas, el flujo del transmisor sináptico, cómo se mueven las extremidades, cómo interactúan los segmentos del cuerpo, hasta cómo nos movemos en nuestro entorno” (Sahrmann, 2017). El movimiento se evidencia desde lo micro (subcelular-celular) hasta lo macro (deambulación) y es el medio que nos permite cumplir con cualquier propósito. A través del movimiento el ser humano, se relaciona con el medio externo y, por otro lado, se experimenta a sí mismo (su medio interno) desarrollando su identidad corporal, experimentando sentimientos y sensaciones. El acto motor se produciría para “satisfacer necesidades de supervivencia, expresar emociones y creencias, asimismo, como un elemento de comunicación e interacción con el medio y con los sujetos que cohabita” (Benjumea, 2010).

No somos cuerpos humanos en movimiento, sino personas en movimiento.

Finalmente, hay que recordar que la construcción plena del movimiento exigirá un procesamiento inconsciente y una intencionalidad consciente.

DE LA COGNICIÓN A LA ACCIÓN

La construcción, planificación y gestión del movimiento es un proceso encefálico con gran repercusión cortical, por esta razón desde la neurociencia se utiliza la frase “el movimiento no es únicamente una magnitud angular, es también una expresión cortical”, indicando que no se trata exclusivamente de movimientos articulares, sino que existe una contribución cerebral muy importante (La Touche, 2019). Esta operación cerebral articula momentos conscientes en los que decidimos ejecutar una orden motora y realizar un gesto o movimiento (angular), pero también incluye una representación detallada del gesto previa al movimiento que sucede de manera inconsciente (cortical). Esta representación utiliza casi la misma circuitería neural que la ejecución angular y supone el sustrato indispensable para ella.

La Imaginería Motora es un perfecto ejemplo de este momento inconsciente pero realizado de manera voluntaria. Tratándose de una habilidad cognitiva y dinámica que implica la representación de una acción, internamente, sin su ejecución real motora (Decety, 1996; Ladda et al. 2021). De este modo, se provoca una activación de las áreas cerebrales relacionadas con la planificación y ejecución del movimiento voluntario y consciente. (Wilson y Knoblich, 2005; Bunno et al. 2015).

Otro ejemplo ejecutado habitualmente es la emulación.

Emular (al igual que la IM) nos permite planificar y representar un movimiento sin llegar a realizarlo, activando simultáneamente las cortezas sensoriomotora y somatosensorial, incluida la información cinestésica, de forma idéntica a si se realiza el movimiento (Patel et al. 2022).

De este modo un movimiento o acción motora, contiene una etapa habitualmente inconsciente o etapa encubierta (cortical) que es una representación del futuro, que incluye el objetivo de la acción, los medios para alcanzarlo, las consecuencias sobre el organismo y sobre el mundo exterior. Y una etapa habitualmente consciente o etapa abierta que sería la ejecución angular (articular). Las etapas encubiertas y abiertas representan un continuo, tal que, cada acción abiertamente ejecutada implica la existencia de una etapa encubierta, sin embargo, una acción encubierta no necesariamente se convierte en una acción abierta. Las acciones encubiertas son de hecho acciones, excepto por el hecho de que no se ejecutan. Existiendo una no despreciable similitud, en términos neuronales, entre el estado neuronal donde se simula (imagina) una acción y el estado de ejecución de esa acción (Jeannerod, 2001; Macuga y Frey, 2012; Patel et al. 2022).

Se conoce que los programas motores almacenados en los sistemas de memoria gracias a esos procesos inconscientes e imaginados (encubiertos) permiten la generación de imágenes mentales motoras sin la necesidad de un estímulo externo. Pero, aportar un estímulo previo a la imaginación-ejecución de la tarea facilita la misma, y provoca una actividad neurofisiológica mayor (Taube et al. 2015). Esto es lo que sucede por ejemplo con una información visual previa o ante un estímulo manual.

Una forma de aprendizaje cerebral consiste en la realización de movimientos. Cuanto más se repite una acción, mejor la anticipa el cerebro y envía los comandos de forma precisa. Esto muestra que en realidad las entradas sensoriales no desencadenan el acto motor (al menos en un cerebro experimentado) más bien, corrigen las estimaciones de probabilidad previa para crear

la posterior probabilidad (remodelación de la predicción), que sirve como creencia sobre las causas de tales entradas en el tiempo presente (Bubic et al. 2010).

Por lo tanto, una entrada sensorial como un estímulo manual (o visual, o cognitivo, o emocional, o auditivo...) serviría para corregir el patrón motor precodificado, y facilitar la regulación, recuperación y expresión del mismo. Este hecho sustentará la hipótesis de trabajo de la presente Tesis Doctoral, justificando la elección del protocolo de tratamiento.

Hay que destacar que, en una estructura biológica, como el cuerpo humano, el movimiento debe realizarse sobre la base de la interconexión e integración de los procesos neuromusculares y neurocognitivos. Responder a la pregunta acerca del por qué nos movemos de una manera específica, se refiere a la pregunta: ¿cómo el sistema nervioso central, produce movimientos coordinados (propiocepción), con el propósito de interacción con el resto del cuerpo (interocepción) y con el medio ambiente (exterocepción)? (Latash, 2010).

Exterocepción (sentidos primarios, ej. el tacto), propiocepción (sensación del movimiento, ej. ubicación del cuerpo en el espacio) e interocepción (sensación interna, ej. condición fisiológica del cuerpo) son fuentes de información que necesitan de un sustrato presente en todo el organismo que interrelacione al resto de estructuras y que posea las características para informar al sistema nervioso de manera continua, representando en sí mismo la continuidad y el comportamiento sistémico. Este sustrato necesario en el que se fundamenta el movimiento será la fascia.

FASCIA Y MOVIMIENTO

La fascia (tejido conectivo), cubre todas las estructuras del cuerpo creando una continuidad estructural que da forma y función a todos los tejidos y órganos. El tejido fascial tiene una distribución ubicua en el sistema corporal; es capaz de envolver, interpenetrar, sostener y formar, el torrente sanguíneo, el tejido óseo, el tejido meníngeo, los órganos y los músculos. La fascia crea diferentes capas interdependientes con varias profundidades, desde la piel hasta el periostio (incluyendo al hueso), formando una estructura mecano-metabólica tridimensional (Bordoni, 2022).

No es casualidad que cuando se busca una definición de fascia se aluda al término “sistema”. La Sociedad de Investigación de la Fascia a través de su Comité de Nomenclatura de Fascia propuso esta definición: “El sistema fascial consiste en el continuo tridimensional de tejidos conectivos fibrosos densos, sueltos y blandos que contienen colágeno que impregnan el cuerpo. Incorpora elementos como tejido adiposo, adventicias y vainas vasculonerviosas, aponeurosis, fascias profundas y superficiales, epineuro, cápsulas articulares, ligamentos, membranas, meninges, expansiones miofasciales, periostio, retináculos, septos, tendones, fascias viscerales, y todo el tejido intramuscular y tejidos conectivos intermusculares que incluyen endomisio/perimisio/epimisio. El sistema fascial rodea, entrelaza e interpenetra todos los órganos, músculos, huesos y fibras nerviosas, dotando al cuerpo de una estructura funcional y proporcionando un entorno que permite que todos los sistemas del cuerpo funcionen de manera integrada” (Adstrum et al. 2017).

Recientemente, Andrzej Pilat (Pilat, 2022) creando una fuerte relación con el movimiento y la función humana ha definido la fascia como: “La red omnipresente, altamente hidratada, ricamente inervada, vascularizada y con capacidad contráctil, un prodigioso sistema biológico complejo, que proporciona una información mecanorreceptiva al cuerpo, facilitando la comunicación, la interacción, la adaptación y la protección”. Este autor entiende el tejido fascial no sólo como un “portador” mecánico pasivo, si no como un “órgano sensorial” de primer orden que, a través de sofisticadas sinergias, facilita la modificación fisiológica de otros sistemas corporales estructurales y funcionales apoyando a todo el cuerpo en sus funciones vitales.

La fascia puede considerarse una red de comunicación continua e ininterrumpida a través de la cual la información relacionada con el movimiento fluye entre y dentro de las estructuras musculares, vasculares, viscerales y neurales.

Durante el movimiento, las sinergias motoras representan la coordinación de los elementos neuronales y físicos incrustados en nuestro cuerpo para optimizar las soluciones a los problemas motores (Garofolini y Svanera 2019). La fascia posibilita la información sistémica neurosensorial y la comunicación físico/corporal para facilitar la resolución de los retos dinámicos.

El tejido fascial contiene células mecanosensibles (por ejemplo, los fibroblastos) inmersas en su matriz extracelular (MEC). Éstas pueden producir colágeno y elastina frente a demandas mecánicas, controlando así la tensión intrínseca de la matriz, llegando incluso (a través de los miofibroblastos) a generar contracciones para provocar un incremento tensional en el sistema, especialmente en condiciones emergentes y/o patológicas (Monument et al. 2015; Schleip et

al. 2019; Tai et al. 2021). Las diferentes células fasciales ancladas en su MEC aseguran la plasticidad (adaptabilidad) del sistema, creando una comunicación intercelular esencial para mantener las condiciones óptimas del organismo y asegurar el correcto movimiento.

En la musculatura, las miofibrillas se encuentran inmersas en su MEC colagenosa. Durante el fenómeno contráctil las miofibrillas ejercen una fuerza desde el interior de la estructura miofascial (endomysio, perimysio y epimysio) hacia las estructuras vecinales. La mayoría de la fuerza contráctil se dirige a las unidades miotendinosas, sin embargo, aproximadamente el 30% de ella utiliza vías de transmisión “epimisiales”, que son paralelas a las vías tendinosas (Huijing 2007). Los enlaces colagenosos entre los epimisios de los músculos adyacentes y con los tractos neurovasculares, proporcionan conexiones intermusculares (Purslow, 2010; Zhang, 2012). Por ejemplo, se ha comprobado que la estimulación eléctrica (contracción) del músculo gastrocnemio conduce a un desplazamiento simultáneo del músculo sóleo (Bojsen-Møller et al. 2010).

Por otro lado, la fascia crea relaciones regionales, creando una red multidireccional de continuidad miofascial para generar coactivaciones y cumplir con tareas amortiguadoras y de transmisión de la fuerza (Wilke et al. 2016). En modelos in vivo, por ejemplo, entre los glúteos y los isquiotibiales con influencia de la dorsiflexión del tobillo (aumento en la cocontracción muscular) (Champagne et al. 2008). Entre los músculos dorsal ancho y glúteo mayor (Carvalhais et al. 2013), relacionando la flexión plantar isométrica con un cambio significativo sobre la tensión de la fascia toracolumbar y el músculo gastrocnemio (Chen et al. 2022). En la dorsiflexión de la articulación del tobillo pudiendo provocar el desplazamiento del gastrocnemio, el semimembranoso

y el cuádriceps femoral (Wilke et al. 2020). O en la conectividad del tejido miofascial a distancia reforzando el concepto funcional de transmisión de fuerza a través de grupos musculares sinérgicos con el movimiento pélvico y el desplazamiento de la fascia profunda en el gastrocnemio medial (Cruz-Montecinos et al. 2015).

Estos ejemplos respaldarían la teoría de que los tejidos conectivos podrían desempeñar un papel importante en la activación muscular y la contracción conjunta a lo largo del cuerpo (Krause et al. 2016). Un ejemplo habitual es la fascia toraco lumbar (FTL). El músculo nunca actúa como una entidad aislada e independiente, la fascia lo interrelaciona estructural y dinámicamente. De este modo disminuye el gasto contráctil cumpliendo con su propósito. Es la eficacia y la eficiencia del movimiento.

Debido a su ubicación, a las relaciones entre unidades miofasciales, y la configuración de sus fibras de colágeno, el tejido fascial puede colaborar durante el movimiento en tareas de estabilización, modulación y amplificación de la fuerza. Algunos ejemplos son: la influencia de la FTL en la estabilización dinámica de la columna lumbar mediante un efecto hidráulico (Choi and Kim, 2017; Fan et al. 2018), y el papel estabilizador de la fascia deltotrapezoide sobre la articulación acromioclavicular (Pastor, 2016).

Por otro lado, los ligamentos lejos de ser estructuras ultra especializadas son parte del sistema fascial, dotados de características colagenosas para participar en la transmisión de las fuerzas, en el control del movimiento y en el mantenimiento de la estabilidad (Pilat, 2022).

El diseño corporal se muestra a través de una organización de planos tisulares superpuestos en diferentes grados de profundidad. Durante cualquier movimiento existe la necesidad del

deslizamiento entre ellos. Ejemplos de ello son los cambios en la forma de los tejidos de la región anterior de la muñeca al realizar la extensión de la misma o el comportamiento del nervio mediano en relación al túnel carpiano al ejecutar el mismo movimiento de muñeca. El deslizamiento permite la deformidad de las estructuras y el logro de la amplitud deseada. El alto grado de hidratación del tejido fascial junto con la presencia de ácido hialurónico entre los diferentes planos fasciales, facilita la disponibilidad de los mecanismos de deslizamiento (Pavan et al. 2014, Langevin, 2021).

En relación con la inervación, la fascia presenta abundantes mecanorreceptores (fibras Aδ y/o C) en sus diferentes estratos, y husos musculares incrustados en los perimisios y endomisios musculares (Banks & Barker 2004; Fede et al. 2020; Magerl et al. 2021; Langevin 2021). De este modo el tejido fascial participa activamente de la propiocepción, la transmisión de la fuerza y el control motor. El papel propioceptivo de la red fascial significa que puede actualizar al sistema nervioso central sobre la tensión mecánica para operar las unidades motoras en el momento, ritmo y etapa de fuerza adecuados (Mense, 2019).

Por último, especialmente a través de las fibras amielínicas polimodales tipo “C” la fascia participa de la interocepción. La interocepción se define como la sensación del estado fisiológico de todo el cuerpo. Constituye una representación del “yo” material y podría proporcionar una base para los sentimientos subjetivos, la emoción y la autoconciencia (Craig, 2002). Los aspectos que lesionan a los tejidos, como el traumatismo, la inflamación y la fibrosis (como sucede tras los tratamientos médicos oncológicos) cambiarán el comportamiento fascial y alterarán profundamente la entrada sensorial derivada de ésta. De este modo, comenzará la perturbación de la “conciencia” interoceptiva.

La interocepción participa junto a numerosos sistemas cerebrales de la toma de decisiones para poder adaptar rápidamente los comportamientos en respuesta a cambios repentinos en su entorno. En otras palabras, los sujetos deben reconocer rápidamente el cambio en las restricciones ambientales y remodelar o cancelar su plan de acción preexistente a favor de uno más funcional (Brockett et al. 2020; Brockett et al. 2021). El tejido fascial en su estado fisiológico facilitará la información y la transmisión dinámica para estas adaptaciones.

La fascia responde, se orienta, se adapta, amortigua, transmite y facilita el movimiento, ocasionando una mayor eficiencia del trabajo muscular, y permitiendo un mejor cumplimiento de la función y de la adaptabilidad humana. Su disfunción tendrá un alto coste.

DISFUNCIÓN FASCIAL

Como se comentó previamente, cualquier proceso traumático, inflamatorio y/o fibrótico afectará el estado y comportamiento del sistema fascial. Después de lo expuesto, entendemos que los efectos pueden expresarse de manera sistémica y, por lo tanto, no limitarse a los tejidos lesionados.

Durante los procesos inflamatorios (especialmente si son prolongados) se liberan citoquinas fibrogénicas que pueden promover la fibrosis a través de la proliferación excesiva de fibroblastos y el depósito de matriz de colágeno, creando una restricción que condicionará el movimiento (Barbe et al. 2013).

La mera presencia de la citoquina ya sensibiliza los nociceptores incidiendo en el dolor fascial. Actualmente, el dolor miofascial se ha conver-

tido en uno de los principales problemas de los sistemas sanitarios. Hasta hace unos años todos los estudios se centraban en las alteraciones musculares, como puntos “gatillo”, pero recientemente se empieza a considerar las fascias como una nueva y posible fuente de dolor nociceptivo (Suarez-Rodriguez et al. 2022). La mayoría de los nociceptores fasciales son fibras tipo “C” con capacidad de liberar antidrómicamente neuropéptidos (sustancia P) con carácter proinflamatorio. De este modo, una agresión fascial puede facilitar a través de su propia inervación un cuadro de tipo inflamatorio neurogénico que posibilite también la experiencia del dolor neuropático.

Volviendo con la fibrosis, Frara y cols. (Frara et al. 2017) mostraron que la citada sustancia P puede estimular la producción de factor de crecimiento transformante beta (TGFβ-1) por parte de los fibroblastos, y que tanto la sustancia P, como el TGFβ-1, pueden inducir procesos fibrogénicos.

De nuevo, con las citoquinas (por ejemplo, interleucina-1β, factor de necrosis tumoral (TNF) y TGFβ-1), presentes en una agresión fascial, hay que destacar un efecto sistémico. Las citoquinas inflamatorias pueden “desbordarse” en el torrente sanguíneo, lo que conlleva un efecto secundario generalizado (Barr y Barbe, 2003; Gao et al. 2013). Por ejemplo, el TNF circulante está elevado en procesos prolongados (como en el dolor lumbar crónico) pudiendo facilitar un cuadro de dolor persistente y sensibilización central (Wang et al. 2008; den Boer et al. 2019).

El escenario fibrótico, los cambios en la cantidad y calidad del ácido hialurónico, así como el aumento de la tensión (aguda o persistente) debido a sobrecargas repetitivas o posturas mantenidas en el tejido fascial, facilitarán un

incremento/desorden mecánico sobre los propioceptores y nociceptores fasciales ocasionando cuadros de dolor y déficit de la motricidad (Langevin, 2021; Pilat, 2022). Por otro lado, el aumento de colágeno alrededor de los nervios puede provocar atrapamientos que condicionen la movilidad neural/corporal y generar dolor de carácter neuropático.

Cómo se verá posteriormente, los pacientes oncológicos que reciben el tratamiento médico exhiben secuelas que comprometen al sistema fascial y sus estructuras relacionadas, ocasionando cuadros de dolor y perturbaciones del movimiento/función. Por todo ello, el tratamiento fascial se puede convertir en una propuesta prioritaria para el manejo de estas secuelas en población oncológica.

INDUCCIÓN MIOFASCIAL

Para la recuperación del movimiento/función la fisioterapia cuenta con numerosas estrategias. Una de las más relevantes es la terapia manual (TM). “Las técnicas de TM consisten en un amplio grupo de intervenciones pasivas en las que el fisioterapeuta emplea sus manos para administrar movimientos precisos diseñados para modular el dolor, incrementar el rango de movimiento articular, reducir o eliminar el edema del tejido conectivo, inflamación o restricción, inducir relajación, mejorar la extensibilidad del tejido contráctil y no contráctil y mejorar la función pulmonar. Estas intervenciones implican variabilidad en técnicas y en grados de aplicación de fuerzas” (American Physical Therapy Association (APTA), 2003).

Esta definición de TM incluye un término que en la actualidad genera controversia y que ha sido utilizado de manera peyorativa por algunos

profesionales: “pasiva”. De hecho, la terminología “hands-off” y “hands-on” apunta en esta dirección. Desde hace algún tiempo ha surgido la idea de que los tratamientos con ejercicio terapéutico (hands-off) son superiores en efectividad ya que incorporan al paciente de manera “activa”, participando de manera voluntaria en su proceso de recuperación. Por el otro lado, los tratamientos que utilizan la TM (hands-on) se les han llamado “pasivos” y se han interpretado como intervenciones en las que el paciente no colaboraba de manera consciente, casi como si no existiera, y el fisioterapeuta lo hiciera todo. Pero nunca es “pasivo”.

Cuando un fisioterapeuta administra un tratamiento con TM el paciente lo recibe (probablemente en la camilla), pero siempre desde una realidad vivida. El organismo humano es mecanosensible y siempre responde de manera “activa” ante los estímulos manuales. De hecho, tanto el ejercicio terapéutico como la TM operan por los efectos mecánicos que generan en los pacientes (Khan y Scott, 2009; Waters-Banker et al. 2014; McKay et al. 2022).

La cuestión tal vez reside en la educación. El paciente debe aprender que el resultado del tratamiento no depende exclusivamente del estímulo administrado por el fisioterapeuta (dependencia) sino que en realidad también depende de su respuesta y colaboración (independencia).

Así que, se propone abandonar los términos “activos” y “pasivos” para referirse a las diferentes estrategias terapéuticas. Todas son “activas” y “colaborativas” porque ante todas el organismo y la persona responden.

Entonces, ¿qué es TM? La TM es una forma de tratamiento basada en el movimiento/estímulo

manual que ocasiona respuestas del organismo, al mejorar la extensibilidad del tejido, modular la respuesta muscular y mejorar la movilidad. Todo tratamiento conlleva los efectos del contexto terapéutico y las expectativas (paciente/terapeuta) que rodea cada intervención (Bialosky et al. 2009; Díaz-Rodríguez et al. 2016). La TM influye en los tejidos periféricos, pero desde ellos provoca cambios (información) sistémicos, incluyendo al sistema nervioso central. Son efectos biomecánicos, efectos mediados periféricamente, efectos mediados por la médula espinal y efectos mediados supraespinalmente (Bishop et al. 2015). La TM es una intervención compleja que involucra múltiples interacciones de mecanismos complementarios (Bialosky et al. 2018).

Esta complejidad se beneficia del trabajo con un sustrato tan relacionado y relevante como el sistema fascial.

Un aspecto destacado de la TM es que se aplica con la mano. El “toque” manual siempre se ha considerado como un poderoso canal de comunicación que desempeña un papel clave en nuestro bienestar emocional y posiblemente en la percepción de uno mismo (Cerritelli et al. 2017). El fisioterapeuta debe facilitar los cambios para lograr la curación a un nivel más holístico. Esto se explica por la siguiente pregunta: ¿Qué tocamos, el cuerpo o la persona? El contacto manual se entiende humanista e interpersonal, como capaz de calmar y curar (Carter y Drew 2012).

La TM es rentable en comparación con otras intervenciones comúnmente proporcionadas (Michaleff et al. 2012) y rara vez se asocia con complicaciones graves (Rubinstein, 2008). De hecho, la TM tiene un perfil de riesgo de eventos adversos similar al del ejercicio y un perfil de riesgo más pequeño que la mayoría de los medicamentos (Carnes et al. 2010).

Numerosos trabajos se han realizado interviniendo con TM en pacientes oncológicos, demostrando su beneficio y seguridad (Krisciunas et al. 2015; Krisciunas et al. 2019; Mao et al. 2017; Izgu et al. 2019).

Recientemente, a través de revisiones sistemáticas y metaanálisis, la TM se ha mostrado eficaz para la recuperación de la fatiga, el dolor y la movilidad en pacientes oncológicos de cáncer de mama (CM), y de cáncer de cabeza y cuello (CCC) (Pinheiro da Silva et al. 2019; Wang et al. 2021; Pattanshetty y Patil, 2022).

Inducción Miofascial (IM) es un concepto terapéutico de TM. Tiene como objetivo la restauración funcional del sistema fascial alterado. IM es un proceso de evaluación y tratamiento en el que el profesional transfiere una ligera fuerza (tracción y/o compresión) al tejido, facilitando la recuperación de la dinámica del sistema fascial. El término “inducción” está relacionado con la facilitación del movimiento en lugar de un estiramiento pasivo del sistema. El resultado es una reacción recíproca del cuerpo que implica una reacción de señalización bioquímica y metabólica y, en última instancia, respuestas fisiológicas. Este proceso pretende remodelar la calidad de la matriz extracelular del tejido conectivo para facilitar y optimizar la información hacia el sistema fascial y dentro de él. Es un proceso controlado por el sistema nervioso central del paciente en el que el profesional actúa como facilitador (Pilat, 2022).

El objetivo final no es el establecimiento de jerarquías estables, sino la facilitación de una adaptación óptima a las exigencias del entorno para cambiar los síntomas dolorosos y recuperar el movimiento (función) alterado.

El tratamiento mediante el enfoque de IM permitir al paciente en la medida de lo posible, un

óptimo restablecimiento de la homeostasis del organismo y de su capacidad de recuperación orgánica. El resultado (cambio de la imagen corporal, mejoras en las capacidades funcionales) debe ser evaluado y apreciado no sólo por el profesional, sino también por el paciente. IM pretende ser un tratamiento centrado en el paciente (Pilat, 2015).

IM se recomienda principalmente para pacientes con problemas ortopédicos, neuro-ortopédicos, postraumáticos y degenerativos, relacionados con el sistema miofascial. Los trabajos de investigación clínica en las dos últimas décadas en esta área son numerosos. Existiendo algunas revisiones sistemáticas que comienzan a mostrar la eficacia de la terapia miofascial (como la IM) (McKenney et al. 2013; Yuan et al. 2015; Ajimsha et al. 2015), aunque aún, hay que aumentar el número de estudios y mejorar la metodología (Laimi et al. 2018).

Aproximadamente en la última década, este concepto terapéutico se ha administrado en pacientes con secuelas derivadas del tratamiento médico oncológico y del propio cáncer.

En 2009 surge el primer trabajo a propósito de un caso con síndrome de la red axilar (banda fibrótica) y limitación de la movilidad (activa y pasiva) del hombro afecto tras mastectomía radical modificada, con extirpación de seis ganglios linfáticos axilares. A través de TM centrada en el sistema fascial se mejoraron los cordones fibrosos y se recuperó la movilidad tras 11 tratamientos distribuidos en 3 semanas (Fourie y Robb, 2009).

En 2012 en un ensayo clínico aleatorizado, Fernández-Lao y col. (Fernández-Lao et al. 2012) tras dos semanas de tratamiento, sugirieron el uso de la IM como una intervención temprana

para reducir la fatiga, mejorar el equilibrio autonómico cardiovascular y estabilizar el estado de ánimo en supervivientes de CM.

En el mismo año, un programa multimodal de 8 semanas centrado en ejercicios de estabilidad lumbo-pélvica e IM, redujo la fatiga, la tensión, la depresión y mejoró el vigor y la fuerza muscular en supervivientes de CM (Cantarero-Villanueva et al. 2018).

De nuevo, Fernández-Lao y cols. (Fernández-Lao et al. 2012), desarrollaron un programa multidimensional de 8 semanas que incluyó ejercicios de fortalecimiento e IM como componentes principales, obteniendo mejoras estadísticamente significativas para el dolor de cuello y hombros, y la reducción de la hiperalgesia por presión generalizada en supervivientes de CM.

De Groef y cols. en un ensayo controlado aleatorizado evidenciaron que la IM es una modalidad de fisioterapia efectiva para disminuir la intensidad del dolor en el brazo en supervivientes de CM a los tres meses, aunque no encontraron beneficios a largo plazo (12 meses) (De Groef et al. 2018).

En 2019 Serra-Añó y cols. realizaron un ensayo controlado y aleatorizado en mujeres sometidas a cirugía conservadora y radioterapia después de la cirugía del CM. Establecieron dos grupos, uno con IM y otro con tratamiento de drenaje linfático manual (placebo). Después de 4 semanas de tratamiento concluyeron que la IM generó beneficios físicos (movimiento general del hombro, funcionalidad y dolor percibido) en la población estudiada (Serra-Añó et al. 2019).

Otro ensayo aleatorizado controlado se centró en una intervención con mujeres que padecían CM y estaban en tratamiento médico. El proto-

colo de tratamiento se desarrolló durante 11 meses con el objetivo de determinar la influencia de la IM en el comportamiento respiratorio y la movilidad torácica. La conclusión de los investigadores fue que la inclusión de IM (junto con relajación post-isométrica) tuvo efectos beneficiosos sobre el sistema respiratorio (Domaszewska et al. 2019).

Rao y Pattanshetty realizaron un estudio experimental para mejorar la mala alineación del torso y el desequilibrio muscular que observaron en pacientes operados de CM. Tras 12 sesiones de IM, más estiramiento y fortalecimiento, consiguieron una mejora significativa en la alineación de la postura, la movilidad cervical y del hombro, la fuerza de los músculos de la parte superior de la espalda y del hombro, y la fuerza de agarre de la mano (Rao y Pattanshetty, 2022).

Por último, un estudio de serie de casos sugiere que la IM (asociada a la movilización articular) mejoró de manera significativa la apertura interincisal máxima en supervivientes de CCC con trismus asociado al tratamiento de radioterapia (McMillan et al. 2022).

Los trabajos con perspectiva clínica presentados muestran el creciente interés hacia la intervención con IM en pacientes oncológicos, sin embargo, el volumen de evidencia es pequeño (en detrimento sobre todo de cabeza y cuello) y recientes revisiones demandan más estudios para confirmar la efectividad en la mejora de la movilidad, disminución del dolor, incremento de la funcionalidad y recuperación de la calidad de vida (De Groef et al. 2015, Lara-Palomo et al. 2021).

Para finalizar, hay que destacar que en 2020 la Organización Mundial de la Salud, a través de su iniciativa “Rehabilitación 2030”, realizó una

revisión sistemática incluyendo 32 guías de recomendaciones de rehabilitación en oncología. El objetivo fue determinar pautas específicas para la atención oncológica. Los hallazgos mostraron pautas que recomiendan servicios de rehabilitación para muchos tipos de cáncer y para diversas secuelas del tratamiento, lo que significa que la rehabilitación es un componente reconocido de la atención oncológica. En esta revisión ya se recomienda la intervención con terapia fascial (como la IM) (Stout et al. 2020).

Hasta la fecha, hemos identificado investigaciones que han aplicado IM en oncología con resultados esperanzadores. Sin embargo, no conocemos ningún estudio que haya propuesto un programa de IM con técnicas sostenidas de “desenrollando” (unwinding) para tratar las secuelas en supervivientes oncológicos.

UNWINDING MIOFASCIAL

Los procedimientos terapéuticos de IM contienen técnicas directas (deslizamientos) e indirectas (sostenidas). Las sostenidas son aplicaciones que busca la facilitación del movimiento (no un estiramiento pasivo) del sistema fascial. La presión y/o tracción aplicada y la consiguiente tensión en el tejido se mantienen en el nivel más bajo posible para modificar la resistencia de los componentes tisulares. Por lo tanto, se trata de una técnica de tacto ligero (Pilat, 2022). Los objetivos marcados serán recuperar la movilidad, eliminar las limitaciones, restablecer el control motor, modular el dolor y devolver la funcionalidad.

Unwinding Miofascial (UM) es una aplicación sostenida de IM. El término “desenrollado” parece haber sido acuñado por la Dra. Viola M. Frymann (Kern 2001; Shea 2007). Durante el

procedimiento, el segmento corporal donde se aplica una ligera tracción desarrolla numerosos movimientos con variaciones en su amplitud y velocidad, generando una respuesta local y general (sistémica) buscando un equilibrio dinámico. Es evidente que no se trata de movimientos patológicos (Huntington, Parkinson, parálisis cerebral o daño medular), sino que se trata de una respuesta terapéutica que parece estar relacionada con la adaptación y la recuperación funcional.

Esta clase de movimientos “espontáneos” (a pesar de estar muy extendidos clínicamente) hasta ahora, no han recibido suficiente atención de la literatura científica.

Normalmente una persona que experimenta movimientos espontáneos no tiene el sentido de voluntariedad que normalmente acompaña a la experiencia de iniciar y controlar la acción. Su expresión es variada, en ocasiones los movimientos resultan familiares, en otras, el paciente los experimenta como algo nuevo y desconocido. Puede observarse una activación muscular local, pero también en lugares lejanos de donde se aplica la técnica, los registros con electromiografía así lo constatan (Bertolucci y Kozasa, 2010). El fisioterapeuta, a través del estímulo mecánico induce movimientos en el paciente, respondiendo con una reacción espontánea. Hay una retroalimentación constante entre lo que percibe el clínico y la respuesta dinámica que expresa el paciente (de manera consciente o inconsciente). Los movimientos espontáneos tienden naturalmente a buscar información y apoyo externo, de este modo se puede mejorar la eficacia con las fuerzas internas y externas para la auto organización y la reconfiguración tensil del sistema fascial (Tozzi et al, 2011; Tozzi et al, 2012). La intervención del sistema nervioso está presente en todo momento, des-

encadenando reflejos motores, modificando y creando imágenes motoras, revisando el estado interoceptivo, explorando sensaciones kinestésicas, y asociando estados emocionales.

El UM podría considerarse como un proceso de ensayo y error en el que la persona lograría descubrir y aprender los movimientos y comportamientos que promueven la salud directamente a partir de la experiencia (Begin et al. 2022). Con el tiempo, esto puede llevar al descubrimiento (aprendizaje) de estrategias dinámicas que ofrezcan mayor precisión y menor esfuerzo. Así, los movimientos espontáneos podrían proporcionar una reducción del estrés y una mayor movilidad (Minasny, 2009). Finalmente, un nuevo y mejorado esquema corporal que permita una conducta más funcional.

Los procesos que subyacen detrás de esta movilidad espontánea son complejos y aún están en revisión. Tras mucha especulación, faltan explicaciones científicas satisfactorias (Ward, 2002).

Los primeros mecanismos que apuntan como responsables son la necesidad inherente del autoajuste y la inteligencia natural del organismo para encontrar su equilibrio tensional a través de respuestas fisiológicas homeostáticas. Un proceso que, desde una memoria tisular, involucra a los tejidos fasciales restringidos, desplegando todo el patrón de vectores disfuncionales encerrados en el movimiento fascial inherente (Kern, 2001; Ward, 2002; Barnes, 2004).

En la actualidad entendemos que, desde el estímulo manual sobre la fascia, provocamos una importante y numerosa información a través de sus mecanorreceptores (Schleip, 2003). Esto supondría una aferencia (entrada sensorial) hacia el sistema nervioso a nivel exteroceptivo, propioceptivo e interoceptivo, que

daría la oportunidad de una reconfiguración (corrección de los errores de predicción) de los mapas corticales (Pilat, 2022). Actuarían el sistema nervioso periférico, central y autonómico. La activación parasimpática está presente y facilita un estado de relajación (Bertolucci, 2008). Desde aquí se posibilita el acceso del paciente a la etapa encubierta en la que podría diseñar el movimiento cortical (acción motora no ejecutada), este proceso puede ocurrir de manera consciente (imagina y representa los movimientos) o inconsciente. El siguiente paso será la ejecución motora (movimiento angular), la etapa abierta, en la que se expresan los movimientos espontáneos, de manera voluntaria o frecuentemente involuntaria (mecanismo ideomotor). La ideomoción es la expresión somática de la imaginería mental, la atención o el pensamiento; por lo tanto, siempre está presente en el paciente (Spitz, 1997; Dorko, 2003; McCarthy, 2007).

De este modo, el estímulo sobre el sistema fascial posibilitaría una ruta de información para conseguir la adaptabilidad (alostasis / homeostasis) a los desafíos mecánicos. El UM sería una oportunidad para facilitar la exploración-aprendizaje de nuevas rutas motoras, mejorando la planificación, la memoria motora y el rendimiento motor. La acción motora resultante (cortical y angular) no estaría planificada externamente, sino diseñada y elegida internamente, por el paciente.

La investigación clínica con el UM es todavía muy escasa, pero los trabajos muestran una mayor fluidez y facilidad del movimiento, menos dolor y una sensación general de ligereza y bienestar, lo que sugiere una función autorreguladora de los movimientos. Normalmente, el paciente experimenta una imagen corporal modificada (Begin et al. 2022).

En 2007, McCarthy (McCarthy, 2007) realizó un trabajo experimental a propósito de un caso con dolor cervical crónico y dolor de la cintura escapular. Aplicando un tratamiento de UM (denominado en su caso como terapia ideomotora) junto con ejercicios de autocontrol durante seis semanas, obtuvo reducciones clínicamente significativas en la intensidad del dolor y la discapacidad percibida.

Tozzi en 2011 y 2012, realizó dos investigaciones (con grupo experimental y grupo control), tratando con procedimientos de IM y UM a un total de 169 pacientes. Los objetivos eran evaluar mediante ecografía dinámica, el cambio de los movimientos de deslizamiento entre las capas superficiales y profundas de la fascia en el cuello, en personas con cervicalgia inespecífica antes y después de la aplicación del tratamiento; evaluar la variación de la distancia reno-diafragmática derecha y de la movilidad del cuello vesical, en pacientes con dolor lumbar inespecífico, antes y después del tratamiento; y por último, la percepción del dolor después del tratamiento a corto plazo. Tras la aplicación del procedimiento de IM y UM se obtuvo una mejora en la movilidad del tejido fascial y una reducción del dolor cervical y lumbar (Tozzi et al. 2011; Tozzi et al. 2012).

En 2017, Goyal y cols., aplicaron IM y UM en una paciente diagnosticada de depresión moderada con síntomas somáticos. Tras 4 semanas de tratamiento los resultados mostraron una mejoría en el cuestionario de depresión de Hamilton, y en la calidad de vida medida mediante el cuestionario de Calidad de Vida, Disfrute y Satisfacción - Forma Corta. Ambas escalas se administraron antes de la intervención y 6 semanas después de la misma. Los autores señalaron la IM y la UM como una importante estrategia de tratamiento adyuvante (Goyal et al. 2017).

Por último, en un estudio de cohorte prospectivo realizado con 28 pacientes hemofílicos, Pérez-Llanes y cols., demostraron que un protocolo de IM y UM aplicado una vez a la semana durante tres semanas, podía mejorar la percepción del dolor y el estado articular (codo). La mejoría se mantuvo tras un periodo de seguimiento de 3 meses. Las maniobras de tratamiento resultaron ser seguras no produciendo sangrado articular (Pérez-Llanes et al. 2020).

Hasta ahora se ha mostrado el potencial de la IM para el tratamiento en pacientes oncológicos, sin embargo, hasta la fecha no conocemos ningún estudio que haya propuesto la intervención con UM para la mejora y resolución de las secuelas de estos pacientes. Se plantean así nuevos retos de investigación.

SECUELAS Y DISFUNCIONES EN PACIENTES ONCOLÓGICOS

Gracias a los avances en el diagnóstico y el tratamiento, cada vez más pacientes sobreviven al cáncer (Arnold et al. 2019). El propio proceso canceroso junto con la mayoría de los agentes terapéuticos (radioterapia, quimioterapia, cirugía, terapia dirigida y terapia hormonal) conllevan efectos secundarios y disfunciones que afectan a la calidad de vida de los supervivientes (Duijts y Spelten 2021). Los tratamientos oncológicos junto con la patología cancerosa pueden ocasionar procesos traumáticos, inflamatorios y/o fibróticos que afectarán el estado y el comportamiento del sistema fascial. Hace años que estos efectos se han identificado. Por ejemplo, la presencia de hipersensibilidad al dolor por presión generalizada bilateral en pacientes con dolor postmastectomía, que a través de puntos gatillo miofasciales expresaban dolor en el cuello y los hombros, sugi-

riendo sensibilización periférica y central (Fernández-Lao et al. 2010; Fernández-Lao et al. 2011). La presencia de fatiga asociada a dolor, depresión y una imagen corporal reducida en mujeres supervivientes de CM (Cantarero-Villanueva et al. 2011). La hiperalgesia muscular por dolor de presión generalizada en la región lumbar y el déficit en la activación de los músculos oblicuos internos (medido ecográficamente) en pacientes que se sometieron a una resección colon-rectal parcial tras sufrir un cáncer de colon (Sánchez-Jiménez et al. 2014). La presencia de un desequilibrio cardiovascular en supervivientes de CM (evaluando la variabilidad cardiaca) con un año de evolución de la enfermedad (Caro-Morán et al. 2016). El insomnio relacionado con el cáncer también es frecuente y parece correlacionarse con niveles elevados de dolor, ansiedad y depresión (Galiano-Castillo et al. 2017). Los pacientes recientemente diagnosticados con cáncer colorrectal presentan una reducción en la masa muscular del multífido lumbar y del músculo transvers abdominal, junto con la disminución de la resistencia abdominal, lo que conduce a un estado de fragilidad (Cruz-Fernández et al. 2020). El deterioro cognitivo relacionado con la quimioterapia es frecuente en pacientes con cáncer, resultando de naturaleza leve a moderada pero con un gran impacto en la calidad de vida (Cerulla Torrente et al. 2020). Por otro lado, la radioterapia utilizada para tratar el cáncer de próstata puede ocasionar toxicidades pélvicas agudas y tardías, siendo las secuelas gastrointestinales y genitourinarias las más comunes, así como otras complicaciones pélvicas (Matta et al. 2019). Por último, las secuelas endocrinas de la terapia del cáncer incluyen alteraciones funcionales en la regulación hipotalámica-pituitaria, tiroidea, paratiroidea, suprarrenal y gonadal, así como complicaciones óseas y metabólicas. La cirugía, la radioterapia, la quimioterapia y la inmunoterapia contribuyen a estas secuelas (Gebauer et al. 2019).

A continuación, nos centraremos en las secuelas y disfunciones relacionadas con el dolor, las alteraciones de la movilidad y el déficit funcional presentes en los pacientes de CM y CCC.

SECUELAS Y DISFUNCIONES EN CÁNCER DE MAMA

En 2020, el CM se convirtió en el cáncer más diagnosticado, con 2,3 millones de casos nuevos a nivel mundial (Sung et al. 2021). Sin embargo, aunque la mortalidad ha disminuido sustancialmente, la incidencia está aumentando lentamente (Sung et al. 2021; Siegel et al. 2021). A pesar de los progresos realizados para reducir los efectos secundarios y mejorar los modelos de atención, siguen existiendo repercusiones tanto a corto como a largo plazo (Duijts y Spelten 2021).

Por ejemplo, la cirugía puede cursar con cuadros dolorosos postoperatorios, como en el caso del dolor postmastectomía (de Miguel-Jimeno et al. 2016). De hecho, el 30% de los pacientes con CM después de la resección presenta dolor persistente por más de tres meses. Este dolor es de características neuropáticas y suele ser de intensidad leve a moderada (aproximadamente el 10% será intenso) (Khan et al. 2020).

En relación con la quimioterapia, es conocida su repercusión sobre los nervios (neurotoxicidad) e influencia en los procesos dolorosos. En los pacientes de CM los síntomas de polineuropatía son comunes y representan una carga para las supervivientes (Bennedsgaard et al. 2022). En ocasiones el tratamiento de elección es la radioterapia pudiendo generar irritabilidad neural. El dolor neuropático puede estar presente mostrando dolor espontáneo en la axila/hombro e hipersensibilidad neural de los principales nervios del miembro superior (mediano, radial y cubital) (Caro et al. 2014).

El dolor se considera el síntoma más frecuente y persistente después del tratamiento del cáncer. La prevalencia del dolor es del 40%, y puede presentarse hasta tres meses después del tratamiento (Evenepoel et al. 2021). El dolor neuropático es el tipo de dolor más reportado (60%), aunque lo más habitual es experimentar una mezcla de dolor nociceptivo y dolor neuropático que a menudo es multifactorial y está relacionado con la propia condición del cáncer subyacente y su tratamiento multimodal (Leysen et al. 2019; Dupoirion et al. 2022). Cuando el dolor se vuelve crónico, la prevalencia puede alcanzar el 30,8% entre las personas con diagnóstico de cáncer (Sanford et al. 2019). En los supervivientes de CM se pueden asociar parestesias, hinchazón de brazo/hombro, sensaciones fantasma y alodinia (Peuckmann et al. 2009). La cronicidad favorece los procesos de sensibilización periférica y central, facilitando el dolor persistente. El 38% de los supervivientes de CM con dolor persistente, tiene signos de sensibilización central (De Groef et al. 2018). El manejo temprano del dolor es fundamental para disminuir la probabilidad de evolucionar hacia dicha sensibilización central (Jordan et al. 2020).

Por otro lado, hasta el 47% de las supervivientes de CM con tratamientos de terapia hormonal, como los inhibidores de la aromatasa, pueden sufrir un síndrome musculoesquelético caracterizado por artralgias, rigidez articular, mialgias y síndrome del túnel carpiano (Spagnolo et al. 2016; El Masri y Phadke, 2022).

Tanto la radioterapia como la cirugía pueden generar restricciones en la región de la axila/hombro que afecten a su comportamiento dinámico. Las mujeres que reciben radiación y quimioterapia después de la mastectomía tienen alteraciones en la movilidad del hombro a largo plazo, restricciones en las extremidades supe-

riores que pueden continuar durante muchos años en las supervivientes de CM (Stuiver et al. 2008; Chrischilles et al. 2019). La asociación del déficit motor también estará presente, identificándose patrones alterados de activación de los músculos cervicales durante tareas funcionales de las extremidades superiores (Galiano-Castillo et al. 2011).

Por lo tanto, los trastornos y el déficit relacionados con el movimiento, así como los procesos dolorosos son una constante en los supervivientes de CM.

SECUELAS Y DISFUNCIONES EN CÁNCER DE CA- BEZA Y CUELLO

El CCC es el sexto cáncer más común en todo el mundo; en 2019 se diagnosticaron más de 550.000 casos nuevos. Su prevalencia en hombres es el doble que en mujeres (Aupérin, 2020).

El tratamiento quirúrgico (resección del tumor y disección del cuello si los ganglios linfáticos están afectados) suele dejar secuelas como dolor y falta de movilidad, dando lugar a disfunción del cuello y hombro (Gane et al. 2017). En ocasiones es necesario realizar una disección radical del cuello pudiendo provocar la parálisis del nervio accesorio espinal y la consecuente disfunción de la extremidad superior y disminución de la movilidad del hombro (Cohen et al. 2016).

Por su parte, la radioterapia puede generar fibrosis, necrosis de partes blandas y osteorradionecrosis (Maghami y Ho, 2018). Por ejemplo, la radioterapia aplicada en la región miofascial de la masticación en pacientes con CCC podría inducir la fibrosis de dichos músculos, dando lugar a un trismo inducido. Este trastorno podría persistir, limitando la funcionalidad oral, durante

años (Wang et al. 2005; Straub et al. 2015). Las estrategias con radioterapia también podrían ocasionar lesiones tanto directas (daño axonal y desmielinización) como indirectas (compresión por fibrosis) en los nervios periféricos incluso años después del tratamiento (Delanian et al. 2012; Pradat y Delanian, 2013).

El uso de la quimioterapia también puede inducir alteraciones sensoriales y motoras (Baggi et al. 2014). El riesgo de desarrollar deficiencias funcionales significativas es aún mayor con la combinación de radioterapia más quimioterapia (Huang et al. 2016).

De este modo, el dolor inducido por el tratamiento en el cuello y el hombro es común en los supervivientes de CCC. De hecho, alrededor del 70% de los pacientes presentan dolor al final del tratamiento, más del 35% a los seis meses posteriores a la finalización (Bossi et al. 2019) e incluso durante los primeros tres años después del diagnóstico (Cramer et al. 2018). Este dolor se considera principalmente nociceptivo, pero también puede ser de origen neuropático e involucrar procesos de sensibilización periféricos y centrales (Ortiz-Comino et al. 2020). El dolor interfiere en la capacidad física, emocional y laboral de los supervivientes de CCC, perjudicando seriamente su calidad de vida y su participación en la sociedad. El dolor percibido por los supervivientes de cáncer se debe principalmente a la inflamación derivada de los procedimientos quirúrgicos, y a la fibrosis inducida por la radiación en los tejidos afectados (Maghami y Ho, 2018).

De manera similar, la función motora en la región facial, mandibular y cervical, así como en regiones adyacentes (cintura escapular y hombro) puede empeorar. Por ejemplo, pueden aparecer daños neurológicos y cambios fibróticos en los

sitios de cirugía y radioterapia, lo que resulta en una reducción del rango de movimiento del cuello, del hombro y de la apertura máxima de la boca, y dificultad en la activación de ciertos grupos musculares. (Moloney et al. 2015; Kraaijenga et al. 2015).

Sin embargo, a pesar de conocerse todo lo expuesto, menos del 60% de ellos reciben una terapia adecuada para estas secuelas (Ringash, 2015).

Tras lo expuesto podemos concluir, que la participación del sistema fascial en el movimiento y la función es clave. Los procesos cancerosos y los tratamientos médicos provocan alteraciones en el tejido fascial ocasionando disfunciones y secuelas que penalizan la calidad de vida de los supervivientes oncológicos, y en particular, de CM y CCC. La IM se muestra como una opción terapéutica para mejorar el tejido fascial y de este modo ser útil en el manejo de la sintomatología derivada. A pesar de que la fisioterapia manual y en concreto la IM han demostrado eficacia en disfunciones y secuelas similares a las que hemos descrito, en general, la evidencia científica existente sobre intervenciones de IM en población oncológica es escasa. Y en relación a las técnicas de UM inexistente hasta donde sabemos. UM se ha mostrado como una opción para restaurar el movimiento y la función consiguiendo la participación del paciente. Todo esto sugiere que la evidencia actual de la fisioterapia manual y en concreto de la IM (representada aquí por la UM), en este caso centrada en el CM y el CCC, se encuentra aún en una fase de desarrollo muy incipiente, plantando así nuevos restos de investigación.

Teniendo en cuenta que la incidencia del cáncer aumenta cada año, las secuelas descritas (más otras no nombradas) provocarán que un gran

número de pacientes necesiten ayuda para recuperar su calidad de vida tras la superación de la enfermedad y la repercusión del tratamiento médico oncológico. Como se ha expuesto, el dolor y las alteraciones del movimiento tienen una alta prevalencia en los supervivientes de CM y CCC. La hipótesis de la presente Tesis Doctoral fue por tanto que un programa de IM (en concreto con UM) puede ser efectivo para modular el dolor, mejorar el movimiento y recuperar la función en supervivientes oncológicos de CM y CCC.

BIBLIOGRAFÍA

- Adstrum, S., Hedley, G., Schleip, R., Stecco, C., & Yucesoy, C. A. (2017). Defining the fascial system. *Journal of bodywork and movement therapies*, 21(1), 173–177. <https://doi.org/10.1016/j.jbmt.2016.11.003>
- Ajimsha, M. S., Al-Mudahka, N. R., & Al-Madzhar, J. A. (2015). Effectiveness of myofascial release: systematic review of randomized controlled trials. *Journal of bodywork and movement therapies*, 19(1), 102–112. <https://doi.org/10.1016/j.jbmt.2014.06.001>
- American Academy of Orthopaedic Manual Physical Therapists. <https://aaompt.org/> (Accedido 20 Junio 2022)
- American Physical Therapy Association. Guiding principles to achieve the vision. Available at: <http://www.apta.org/Vision/> (Accedido 20 Junio 2022)
- APTA – American Physical Therapy Association. Alexandria, VA. (2015) Physical therapist practice and the human movement system [White paper].
- Arnold, M., Rutherford, M. J., Bardot, A., Ferlay, J., Andersson, T. M., Myklebust, T. Å., Tervonen,

H., Thursfield, V., Ransom, D., Shack, L., Woods, R. R., Turner, D., Leonfellner, S., Ryan, S., Saint-Jacques, N., De, P., McClure, C., Ramanakumar, A. V., Stuart-Panko, H., Engholm, G., ... Bray, F. (2019). Progress in cancer survival, mortality, and incidence in seven high-income countries 1995-2014 (ICBP SURVMARK-2): a population-based study. *The Lancet. Oncology*, 20(11), 1493–1505. [https://doi.org/10.1016/S1470-2045\(19\)30456-5](https://doi.org/10.1016/S1470-2045(19)30456-5)

Aupérin A. (2020). Epidemiology of head and neck cancers: an update. *Current opinion in oncology*, 32(3), 178–186. <https://doi.org/10.1097/CCO.0000000000000629>

Baggi F., Santoro L., Grosso E., Zanetti C., Bonacosca E., Sandrin F., Massaro M.A., Tradati N., Simoncini M.C. (2014). Recupero Motorio e Funzionale Dopo Dissezione Latero-Cervicale Del Collo: Due Programmi Di Fisioterapia Precoce a Confronto. *Acta Otorhinolaryngol. Ital.*, 34:230–240.

Banks RW, Barker D. (2004). The muscle spindle. In: Engel AG, Franzini-Armstrong C, editors. *Myology* 3rd ed:489–509. McGraw-Hill.

Barbe, M. F., Gallagher, S., & Popoff, S. N. (2013). Serum biomarkers as predictors of stage of work-related musculoskeletal disorders. *The Journal of the American Academy of Orthopaedic Surgeons*, 21(10), 644–646. <https://doi.org/10.5435/JAAOS-21-10-644>

Barnes JF. (2004). Myofascial release: the missing link in traditional treatment. In: Davis CM, editor. *Complementary Therapies in Rehabilitation: Evidence for Efficacy in Therapy, Prevention, and Wellness*. 59–82. Thorofare, New Jersey: Slack Incorporated.

Barr, A. E., & Barbe, M. F. (2004). Inflammation reduces physiological tissue tolerance in the development of work-related musculoskeletal disorders. *Journal of electromyography and kinesiology: official journal of the International Society*

of Electrophysiological Kinesiology, 14(1), 77–85. <https://doi.org/10.1016/j.jelekin.2003.09.008>

Begin, J., Bertolucci, L. F., Blostein, D., & Minasny, B. (2022). Characterizing a Common Class of Spontaneous Movements. *International journal of therapeutic massage & bodywork*, 15(3), 4–17. <https://doi.org/10.3822/ijtm.v15i3.719>

Bemjumea, M. (2010). *La motricidad como dimensión humana. Un abordaje transdisciplinar*. España: Léeme.

Bennedsgaard, K., Grosen, K., Attal, N., Bouhassira, D., Crombez, G., Jensen, T. S., Bennett, D. L., Ventzel, L., Andersen, I. S., & Finnerup, N. B. (2022). Neuropathy and pain after breast cancer treatment: a prospective observational study. *Scandinavian journal of pain*, 10.1515/sjpain-2022-0017. Advance online publication. <https://doi.org/10.1515/sjpain-2022-0017>

Bertolucci L. F. (2008). Muscle Repositioning: a new verifiable approach to neuro-myofascial release?. *Journal of bodywork and movement therapies*, 12(3), 213–224. <https://doi.org/10.1016/j.jbmt.2008.05.002>

Bertolucci, L. F., & Kozasa, E. H. (2010). Sustained manual loading of the fascial system can evoke tonic reactions: preliminary results. *International journal of therapeutic massage & bodywork*, 3(1), 12–14. <https://doi.org/10.3822/ijtm.v3i1.76>

Bialosky, J. E., Beneciuk, J. M., Bishop, M. D., Coronado, R. A., Penza, C. W., Simon, C. B., & George, S. Z. (2018). Unraveling the Mechanisms of Manual Therapy: Modeling an Approach. *The Journal of orthopaedic and sports physical therapy*, 48(1), 8–18. <https://doi.org/10.2519/jospt.2018.7476>

Bialosky, J. E., Bishop, M. D., Price, D. D., Robinson, M. E., & George, S. Z. (2009). The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model.

Manual therapy, 14(5), 531–538. <https://doi.org/10.1016/j.math.2008.09.001>

Bishop, M. D., Torres-Cueco, R., Gay, C. W., Lluch-Girbés, E., Beneciuk, J. M., & Bialosky, J. E. (2015). What effect can manual therapy have on a patient's pain experience?. *Pain management*, 5(6), 455–464. <https://doi.org/10.2217/pmt.15.39>

Bispo, JP. La fisioterapia en los sistemas de salud: marco teórico y fundamentos para una práctica integral. *Salud Colectiva* [online]. v. 17 [Accedido 1 Agosto 2022], e3709. ISSN 1851-8265. <https://doi.org/10.18294/sc.2021.3709>.

Bojsen-Møller, J., Schwartz, S., Kalliokoski, K. K., Finni, T., & Magnusson, S. P. (2010). Inter-muscular force transmission between human plantarflexor muscles in vivo. *Journal of applied physiology (Bethesda, Md. : 1985)*, 109(6), 1608–1618. <https://doi.org/10.1152/japplphysiol.01381.2009>

Bonatesta, L., Ruiz-Cárdenas, J. D., Fernández-Azorín, L., & Rodríguez-Juan, J. J. (2022). Pain Science Education Plus Exercise Therapy in Chronic Nonspecific Spinal Pain: A Systematic Review and Meta-analyses of Randomized Clinical Trials. *The journal of pain*, 23(4), 535–546. <https://doi.org/10.1016/j.jpain.2021.09.006>

Bordoni, B., Escher, A. R., Tobbi, F., Pianese, L., Ciardo, A., Yamahata, J., Hernandez, S., & Sanchez, O. (2022). Fascial Nomenclature: Update 2022. *Cureus*, 14(6), e25904. <https://doi.org/10.7759/cureus.25904>

Bordoni, B., Mahabadi, N., & Varacallo, M. (2022). Anatomy, Fascia. In *StatPearls*. StatPearls Publishing.

Bossi, P., Giusti, R., Tarsitano, A., Airolidi, M., De Sanctis, V., Caspiani, O., Alterio, D., Tartaro, T., Alfieri, S., & Siano, M. (2019). The point of pain

in head and neck cancer. *Critical reviews in oncology/hematology*, 138, 51–59. <https://doi.org/10.1016/j.critrevonc.2019.04.001>

Broberg C, Aars M, Beckmann K, Emaus N, Lehto P, Lähteenmäki M, Thys W, Vandenberghe R. (2003). A Conceptual Framework for Curriculum Design in Physiotherapy Education – an International Perspective, *Advances in Physiotherapy*, 5(4), 161–168, DOI: 10.1080/14038190310017598

Brockett, A. T., & Roesch, M. R. (2021). Anterior cingulate cortex and adaptive control of brain and behavior. *International review of neurobiology*, 158, 283–309. <https://doi.org/10.1016/bs.irn.2020.11.013>

Brockett, A. T., Tennyson, S. S., deBettencourt, C. A., Gaye, F., & Roesch, M. R. (2020). Anterior cingulate cortex is necessary for adaptation of action plans. *Proceedings of the National Academy of Sciences of the United States of America*, 117(11), 6196–6204. <https://doi.org/10.1073/pnas.1919303117>

Bubic, A., von Cramon, D. Y., & Schubotz, R. I. (2010). Prediction, cognition and the brain. *Frontiers in human neuroscience*, 4, 25. <https://doi.org/10.3389/fnhum.2010.00025>

Bunno, Y., Suzuki, T., & Iwatsuki, H. (2015). Motor imagery muscle contraction strength influences spinal motor neuron excitability and cardiac sympathetic nerve activity. *Journal of physical therapy science*, 27(12), 3793–3798. <https://doi.org/10.1589/jpts.27.3793>

Cameron M.H. (2009). *Agentes físicos en rehabilitación*. Barcelona: Elsevier.

Cantarero-Villanueva, I., Fernández-Lao, C., Del Moral-Avila, R., Fernández-de-Las-Peñas, C., Feriche-Fernández-Castanys, M. B., & Arroyo-Morales, M. (2012). Effectiveness of core stability exercises and recovery myofascial release massage on

fatigue in breast cancer survivors: a randomized controlled clinical trial. *Evidence-based complementary and alternative medicine : eCAM*, 2012, 620619. <https://doi.org/10.1155/2012/620619>

Cantarero-Villanueva, I., Fernández-Lao, C., Fernández-DE-Las-Peñas, C., Díaz-Rodríguez, L., Sanchez-Cantalejo, E., & Arroyo-Morales, M. (2011). Associations among musculoskeletal impairments, depression, body image and fatigue in breast cancer survivors within the first year after treatment. *European journal of cancer care*, 20(5), 632–639. <https://doi.org/10.1111/j.1365-2354.2011.01245.x>

Cardona Arenas B. (2013). Envejecer en el antiguo Egipto. *Una perspectiva médica, farmacéutica y cultural*. 978-84-490-3726-9 / Universidad Autónoma de Barcelona. Servicio de Publicaciones.

Carnes, D., Mars, T. S., Mullinger, B., Froud, R., & Underwood, M. (2010). Adverse events and manual therapy: a systematic review. *Manual therapy*, 15(4), 355–363. <https://doi.org/10.1016/j.math.2009.12.006>

Caro-Morán, E., Díaz-Rodríguez, L., Cantarero-Villanueva, I., Galiano-Castillo, N., Arroyo-Morales, M., & Fernández-Lao, C. (2014). Nerve pressure pain hypersensitivity and upper limb mechanosensitivity in breast cancer survivors: a case-control study. *Pain medicine (Malden, Mass.)*, 15(10), 1715–1723. <https://doi.org/10.1111/pme.12567>

Caro-Morán, E., Fernández-Lao, C., Galiano-Castillo, N., Cantarero-Villanueva, I., Arroyo-Morales, M., & Díaz-Rodríguez, L. (2016). Heart Rate Variability in Breast Cancer Survivors After the First Year of Treatments: A Case-Controlled Study. *Biological research for nursing*, 18(1), 43–49. <https://doi.org/10.1177/1099800414568100>

Carter S, Drew L (2012). Touch in the consultation. *British Journal of General Practice*, 62(596):147–148. <https://doi.org/10.3399/bjgp12X630133>

Carvalhois, V. O., Ocarino, J., Araújo, V. L., Souza, T. R., Silva, P. L., & Fonseca, S. T. (2013). Myofascial force transmission between the latissimus dorsi and gluteus maximus muscles: an in vivo experiment. *Journal of biomechanics*, 46(5), 1003–1007. <https://doi.org/10.1016/j.jbiomech.2012.11.044>

Cerritelli, F., Chiacchiarretta, P., Gambi, F., & Ferretti, A. (2017). Effect of Continuous Touch on Brain Functional Connectivity Is Modified by the Operator's Tactile Attention. *Frontiers in human neuroscience*, 11, 368. <https://doi.org/10.3389/fnhum.2017.00368>

Champagne, A., Descarreaux, M., & Lafond, D. (2008). Back and hip extensor muscles fatigue in healthy subjects: task-dependency effect of two variants of the Sorensen test. *European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society*, 17(12), 1721–1726. <https://doi.org/10.1007/s00586-008-0782-y>

Chen, B., Cui, S., Xu, M., Zhang, Z., & Liu, C. (2022). Effects of Isometric Plantar-Flexion on the Lower Limb Muscle and Lumbar Tissue Stiffness. *Frontiers in bioengineering and biotechnology*, 9, 810250. <https://doi.org/10.3389/fbioe.2021.810250>

Choi, H. W., & Kim, Y. E. (2017). Effect of lumbar fasciae on the stability of the lower lumbar spine. *Computer methods in biomechanics and biomedical engineering*, 20(13), 1431–1437. <https://doi.org/10.1080/10255842.2017.1370459>

Chrischilles, E. A., Riley, D., Letuchy, E., Koehler, L., Neuner, J., Jernigan, C., Gryzlak, B., Segal, N., McDowell, B., Smith, B., Sugg, S. L., Armer, J. M., & Lizarraga, I. M. (2019). Upper extremity disability and quality of life after breast cancer treatment in the Greater Plains Collaborative clinical research network. *Breast cancer research and treatment*,

175(3), 675–689. <https://doi.org/10.1007/s10549-019-05184-1>

Cohen, E. E., LaMonte, S. J., Erb, N. L., Beckman, K. L., Sadeghi, N., Hutcheson, K. A., Stubblefield, M. D., Abbott, D. M., Fisher, P. S., Stein, K. D., Lyman, G. H., & Pratt-Chapman, M. L. (2016). American Cancer Society Head and Neck Cancer Survivorship Care Guideline. *CA: a cancer journal for clinicians*, 66(3), 203–239. <https://doi.org/10.3322/caac.21343>

Cott C, Finch E, Gasner D, Yoshida K, Thomas S, Verrier M. (1995). The movement continuum theory of physical therapy. *Physiotherapy Canada*, 47(2):87-96.

Craig A. D. (2002). How do you feel? Interoception: the sense of the physiological condition of the body. *Nature reviews. Neuroscience*, 3(8), 655–666. <https://doi.org/10.1038/nrn894>

Cramer, J. D., Johnson, J. T., & Nilsen, M. L. (2018). Pain in Head and Neck Cancer Survivors: Prevalence, Predictors, and Quality-of-Life Impact. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*, 159(5), 853–858. <https://doi.org/10.1177/0194599818783964>

Cruz-Montecinos, C., González Blanche, A., López Sánchez, D., Cerda, M., Sanzana-Cuche, R., & Cuesta-Vargas, A. (2015). In vivo relationship between pelvis motion and deep fascia displacement of the medial gastrocnemius: anatomical and functional implications. *Journal of anatomy*, 227(5), 665–672. <https://doi.org/10.1111/joa.12370>

De Groef, A., Meeus, M., De Vrieze, T., Vos, L., Van Kampen, M., Geraerts, I., & Devoogdt, N. (2018). Unraveling Self-Reported Signs of Central Sensitization in Breast Cancer Survivors with Upper Limb Pain: Prevalence Rate and Contributing Factors. *Pain physician*, 21(3), E247–E256.

De Groef, A., Van Kampen, M., Dieltjens, E., Christiaens, M. R., Neven, P., Geraerts, I., & Devoogdt, N. (2015). Effectiveness of postoperative physical therapy for upper-limb impairments after breast cancer treatment: a systematic review. *Archives of physical medicine and rehabilitation*, 96(6), 1140–1153. <https://doi.org/10.1016/j.apmr.2015.01.006>

De Groef, A., Van Kampen, M., Vervloesem, N., Dieltjens, E., Christiaens, M. R., Neven, P., Vos, L., De Vrieze, T., Geraerts, I., & Devoogdt, N. (2018). Effect of myofascial techniques for treatment of persistent arm pain after breast cancer treatment: randomized controlled trial. *Clinical rehabilitation*, 32(4), 451–461. <https://doi.org/10.1177/0269215517730863>

de Miguel-Jimeno, J. M., Forner-Cordero, I., Zabala-Azparren, M., & Matute-Tobias, B. (2016). Síndrome de dolor posmastectomía en nuestro medio: características, tratamiento y experiencia con gabapentina. *Revista de neurología*, 62(6), 258–266.

Dean, E., de Andrade, A. D., O'Donoghue, G., Skinner, M., Umereh, G., Beenen, P., Cleaver, S., Afzalzada, D., Delaune, M. F., Footer, C., Gannotti, M., Gappmaier, E., Figl-Hertlein, A., Henderson, B., Hudson, M. K., Spiteri, K., King, J., Klug, J. L., Laakso, E. L., LaPier, T., ... Wong, W. P. (2014). The Second Physical Therapy Summit on Global Health: developing an action plan to promote health in daily practice and reduce the burden of non-communicable diseases. *Physiotherapy theory and practice*, 30(4), 261–275. <https://doi.org/10.3109/09593985.2013.856977>

Decety J. (1996). The neurophysiological basis of motor imagery. *Behavioural brain research*, 77(1-2), 45–52. [https://doi.org/10.1016/0166-4328\(95\)00225-1](https://doi.org/10.1016/0166-4328(95)00225-1)

Delanian, S., Lefaix, J. L., & Pradat, P. F. (2012). Radiation-induced neuropathy in cancer survivors. *Radiotherapy and oncology : journal of*

the European Society for Therapeutic Radiology and Oncology, 105(3), 273–282. <https://doi.org/10.1016/j.radonc.2012.10.012>

Den Boer, C., Dries, L., Terluin, B., van der Wouden, J. C., Blankenstein, A. H., van Wilgen, C. P., Lucassen, P., & van der Horst, H. E. (2019). Central sensitization in chronic pain and medically unexplained symptom research: A systematic review of definitions, operationalizations and measurement instruments. *Journal of psychosomatic research*, 117, 32–40. <https://doi.org/10.1016/j.jpsychores.2018.12.010>

Dolbow, D. R., Gorgey, A. S., Sutor, T. W., Bochekezanian, V., & Musselman, K. (2021). Invasive and Non-Invasive Approaches of Electrical Stimulation to Improve Physical Functioning after Spinal Cord Injury. *Journal of clinical medicine*, 10(22), 5356. <https://doi.org/10.3390/jcm10225356>

Domaszewska, K., Pieńkowski, T., Janiak, A., Bukowska, D., & Laurentowska, M. (2019). The Influence of Soft Tissue Therapy on Respiratory Efficiency and Chest Mobility of Women Suffering from Breast Cancer. *International journal of environmental research and public health*, 16(24), 5092. <https://doi.org/10.3390/ijerph16245092>

Dorko BL. (2003). The analgesia of movement: ideomotor activity and manual care. *J Osteopath Med*, 6:93–95.

Duijts, S., & Spelten, E. R. (2021). Cancer Survivorship Issues: Dissemination and Translation of Evidence-Based Knowledge. *Cancers*, 13(22), 5794. <https://doi.org/10.3390/cancers13225794>

Dupoiron, D., Jubier-Hamon, S., Seegers, V., Benfait, F., Pluchon, Y. M., Lebre, N., Jaoul, V., & Delorme, T. (2022). Peripheral Neuropathic Pain Following Breast Cancer: Effectiveness and Tolerability of High-Concentration Capsaicin Patch. *Journal of pain research*, 15, 241–255. <https://doi.org/10.2147/JPR.S341378>

El Masri, J., & Phadke, S. (2022). Breast Cancer Epidemiology and Contemporary Breast Cancer Care: A Review of the Literature and Clinical Applications. *Clinical obstetrics and gynecology*, 65(3), 461–481. <https://doi.org/10.1097/GRF.0000000000000721>

Evenepoel, M., Haenen, V., De Baerdemaeker, T., Meeus, M., Devoogdt, N., Dams, L., Van Dijk, S., Van der Gucht, E., & De Groef, A. (2022). Pain Prevalence During Cancer Treatment: A Systematic Review and Meta-Analysis. *Journal of pain and symptom management*, 63(3), e317–e335. <https://doi.org/10.1016/j.jpainsymman.2021.09.011>

Fan, C., Fede, C., Gaudreault, N., Porzionato, A., Macchi, V., De Caro, R., & Stecco, C. (2018). Anatomical and functional relationships between external abdominal oblique muscle and posterior layer of thoracolumbar fascia. *Clinical anatomy (New York, N.Y.)*, 31(7), 1092–1098. <https://doi.org/10.1002/ca.23248>

Fede, C., Porzionato, A., Petrelli, L., Fan, C., Pirri, C., Biz, C., De Caro, R., & Stecco, C. (2020). Fascia and soft tissues innervation in the human hip and their possible role in post-surgical pain. *Journal of orthopaedic research : official publication of the Orthopaedic Research Society*, 38(7), 1646–1654. <https://doi.org/10.1002/jor.24665>

Fernández-Lao, C., Cantarero-Villanueva, I., Díaz-Rodríguez, L., Cuesta-Vargas, A. I., Fernández-Delas-Peñas, C., & Arroyo-Morales, M. (2012). Attitudes towards massage modify effects of manual therapy in breast cancer survivors: a randomised clinical trial with crossover design. *European journal of cancer care*, 21(2), 233–241. <https://doi.org/10.1111/j.1365-2354.2011.01306.x>

Fernández-Lao, C., Cantarero-Villanueva, I., Fernández-de-Las-Peñas, C., del Moral-Ávila, R., Castro-Sánchez, A. M., & Arroyo-Morales, M. (2012).

Effectiveness of a multidimensional physical therapy program on pain, pressure hypersensitivity, and trigger points in breast cancer survivors: a randomized controlled clinical trial. *The Clinical journal of pain*, 28(2), 113–121. <https://doi.org/10.1097/AJP.0b013e318225dc02>

Fernández-Lao, C., Cantarero-Villanueva, I., Fernández-de-Las-Peñas, C., Del-Moral-Ávila, R., Arendt-Nielsen, L., & Arroyo-Morales, M. (2010). Myofascial trigger points in neck and shoulder muscles and widespread pressure pain hypersensitivity in patients with postmastectomy pain: evidence of peripheral and central sensitization. *The Clinical journal of pain*, 26(9), 798–806. <https://doi.org/10.1097/AJP.0b013e3181f18c36>

Fernández-Lao, C., Cantarero-Villanueva, I., Fernández-de-las-Peñas, C., Del-Moral-Ávila, R., Menjón-Beltrán, S., & Arroyo-Morales, M. (2011). Widespread mechanical pain hypersensitivity as a sign of central sensitization after breast cancer surgery: comparison between mastectomy and lumpectomy. *Pain medicine (Malden, Mass.)*, 12(1), 72–78. <https://doi.org/10.1111/j.1526-4637.2010.01027.x>

Fioratti, I., Miyamoto, G. C., Fandim, J. V., Ribeiro, C., Batista, G. D., Freitas, G. E., Palomo, A. S., Reis, F., Costa, L., Maher, C. G., & Saragiotto, B. T. (2022). Feasibility, Usability, and Implementation Context of an Internet-Based Pain Education and Exercise Program for Chronic Musculoskeletal Pain: Pilot Trial of the ReabilitaDOR Program. *JMIR formative research*, 6(8), e35743. <https://doi.org/10.2196/35743>

Fourie, W. J., & Robb, K. A. (2009). Physiotherapy management of axillary web syndrome following breast cancer treatment: discussing the use of soft tissue techniques. *Physiotherapy*, 95(4), 314–320. <https://doi.org/10.1016/j.physio.2009.05.001>

Frara, N., Fisher, P. W., Zhao, Y., Tarr, J. T., Amin, M., Popoff, S. N., & Barbe, M. F. (2018). Sub-

stance P increases CCN2 dependent on TGF-beta yet Collagen Type I via TGF-beta1 dependent and independent pathways in tenocytes. *Connective tissue research*, 59(1), 30–44. <https://doi.org/10.1080/03008207.2017.1297809>

Galiano-Castillo, N., Fernández-Lao, C., Cantarero-Villanueva, I., Fernández-de-Las-Peñas, C., Menjón-Beltrán, S., & Arroyo-Morales, M. (2011). Altered pattern of cervical muscle activation during performance of a functional upper limb task in breast cancer survivors. *American journal of physical medicine & rehabilitation*, 90(5), 349–355. <https://doi.org/10.1097/PHM.0b013e318214e406>

Gane, E. M., Michaleff, Z. A., Cottrell, M. A., McPhail, S. M., Hatton, A. L., Panizza, B. J., & O'Leary, S. P. (2017). Prevalence, incidence, and risk factors for shoulder and neck dysfunction after neck dissection: A systematic review. *European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology*, 43(7), 1199–1218. <https://doi.org/10.1016/j.ejso.2016.10.026>

Gao, H. G., Fisher, P. W., Lambi, A. G., Wade, C. K., Barr-Gillespie, A. E., Popoff, S. N., & Barbe, M. F. (2013). Increased serum and musculotendinous fibrogenic proteins following persistent low-grade inflammation in a rat model of long-term upper extremity overuse. *PloS one*, 8(8), e71875. <https://doi.org/10.1371/journal.pone.0071875>

Garofolini, A., & Svanera, D. (2019). Fascial organisation of motor synergies: a hypothesis. *European journal of translational myology*, 29(3), 8313. <https://doi.org/10.4081/ejtm.2019.8313>

Gilbert A, Carnot P. (1921). *Biblioteca de Terapéutica*. Barcelona: Salvat.

Goyal, M., Goyal, K., Bathla, M., Kanimozhi, D., & Narkeesh, D. (2017). Efficacy of Myofascial

Unwinding and Myofascial Release Technique in a Patient with Somatic Symptoms - A Case Report. *Indian journal of psychological medicine*, 39(2), 199–201. <https://doi.org/10.4103/0253-7176.203113>

Huang, J., Zhang, J., Shi, C., Liu, L., & Wei, Y. (2016). Survival, recurrence and toxicity of HN-SCC in comparison of a radiotherapy combination with cisplatin versus cetuximab: a meta-analysis. *BMC cancer*, 16(1), 689. <https://doi.org/10.1186/s12885-016-2706-2>

Huijing P. A. (2007). Epimuscular myofascial force transmission between antagonistic and synergistic muscles can explain movement limitation in spastic paresis. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology*, 17(6), 708–724. <https://doi.org/10.1016/j.jelekin.2007.02.003>

Izgu, N., Metin, Z. G., Karadas, C., Ozdemir, L., Çetin, N., & Demirci, U. (2019). Prevention of chemotherapy-induced peripheral neuropathy with classical massage in breast cancer patients receiving paclitaxel: An assessor-blinded randomized controlled trial. *European journal of oncology nursing : the official journal of European Oncology Nursing Society*, 40, 36–43. <https://doi.org/10.1016/j.ejon.2019.03.002>

Jeannerod M. (2001). Neural simulation of action: a unifying mechanism for motor cognition. *NeuroImage*, 14(1 Pt 2), S103–S109. <https://doi.org/10.1006/nimg.2001.0832>

Jordan, B., Margulies, A., Cardoso, F., Cavaletti, G., Hagnes, H. S., Jahn, P., Le Rhun, E., Preusser, M., Scotté, F., Taphoorn, M., Jordan, K., ESMO Guidelines Committee. Electronic address: clinicalguidelines@esmo.org, EONS Education Working Group. Electronic address: eons.secretariat@cancernurse.eu, & EANO Guideline Committee. Electronic address: office@eano.eu (2020). Sys-

temic anticancer therapy-induced peripheral and central neurotoxicity: ESMO-EONS-EANO Clinical Practice Guidelines for diagnosis, prevention, treatment and follow-up. *Annals of oncology : official journal of the European Society for Medical Oncology*, 31(10), 1306–1319. <https://doi.org/10.1016/j.annonc.2020.07.003>

Kern M. (2001). *Wisdom in the Body: The Craniosacral Approach to Essential Health*. Berkeley, California: North Atlantic Books.

Khan, J. S., Ladha, K. S., Abdallah, F., & Clarke, H. (2020). Treating Persistent Pain After Breast Cancer Surgery. *Drugs*, 80(1), 23–31. <https://doi.org/10.1007/s40265-019-01227-5>

Khan, K. M., & Scott, A. (2009). Mechanotherapy: how physical therapists' prescription of exercise promotes tissue repair. *British journal of sports medicine*, 43(4), 247–252. <https://doi.org/10.1136/bjsm.2008.054239>

Kraaijenga, S. A., Oskam, I. M., van der Molen, L., Hamming-Vrieze, O., Hilgers, F. J., & van den Brekel, M. W. (2015). Evaluation of long term (10-years+) dysphagia and trismus in patients treated with concurrent chemo-radiotherapy for advanced head and neck cancer. *Oral oncology*, 51(8), 787–794. <https://doi.org/10.1016/j.oraloncology.2015.05.003>

Krause F., Wilke J., Vogt L., Banzer W. (2016). Intermuscular force transmission along myofascial chains: a systematic review. *Journal of Anatomy* 228, 910-918. <https://doi.org/10.1111/joa.12464>

Krisciunas, G. P., Golan, H., Marinko, L. N., Pearson, W., Jalisi, S., & Langmore, S. E. (2016). A novel manual therapy programme during radiation therapy for head and neck cancer - our clinical experience with five patients. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology &*

Cervico-Facial Surgery, 41(4), 425–431. <https://doi.org/10.1111/coa.12535>

Krisciunas, G. P., Vakharia, A., Lazarus, C., Taborda, S. G., Martino, R., Hutcheson, K., McCulloch, T., & Langmore, S. E. (2019). Application of Manual Therapy for Dysphagia in Head and Neck Cancer Patients: A Preliminary National Survey of Treatment Trends and Adverse Events. *Global advances in health and medicine*, 8, 2164956119844151. <https://doi.org/10.1177/2164956119844151>

La Touche R. (2020). Métodos de representación del movimiento en rehabilitación. Construyendo un marco conceptual para la aplicación en clínica. *MOVE [Internet]*. [citado 16 de septiembre de 2022];2(2):152-9. Disponible en: <https://jomts.com/index.php/MOVE/article/view/42>

La Touche, R. (2019). El movimiento como eje fundamental de la rehabilitación. *NeuroRehab News*, 3 (1): e0033.

Ladda, A. M., Lebon, F., & Lotze, M. (2021). Using motor imagery practice for improving motor performance - A review. *Brain and cognition*, 150, 105705. <https://doi.org/10.1016/j.bandc.2021.105705>

Laimi, K., Mäkilä, A., Bärlund, E., Katajapuu, N., Oksanen, A., Seikkula, V., Karppinen, J., & Saltychev, M. (2018). Effectiveness of myofascial release in treatment of chronic musculoskeletal pain: a systematic review. *Clinical rehabilitation*, 32(4), 440–450. <https://doi.org/10.1177/0269215517732820>

Laín Entralgo P. (2014). *Historia de La Medicina*. Alicante: Biblioteca Virtual Miguel de Cervantes; <http://www.cervantesvirtual.com/obra/historia-de-la-medicina/>.

Langevin H. M. (2021). Fascia Mobility, Proprioception, and Myofascial Pain. *Life (Basel, Switzerland)*, 11(7), 668. <https://doi.org/10.3390/life11070668>

Lara-Palomo, I. C., Castro-Sánchez, A. M., Córdoba-Peláez, M. M., Albornoz-Cabello, M., & Ortiz-Comino, L. (2021). Effect of Myofascial Therapy on Pain and Functionality of the Upper Extremities in Breast Cancer Survivors: A Systematic Review and Meta-Analysis. *International journal of environmental research and public health*, 18(9), 4420. <https://doi.org/10.3390/ijerph18094420>

Latash M. L. (2010). Motor synergies and the equilibrium-point hypothesis. *Motor control*, 14(3), 294–322. <https://doi.org/10.1123/mcj.14.3.294>

Leysen, L., Adriaenssens, N., Nijs, J., Pas, R., Bilterys, T., Vermeir, S., Lahousse, A., & Beckwée, D. (2019). Chronic Pain in Breast Cancer Survivors: Nociceptive, Neuropathic, or Central Sensitization Pain?. *Pain practice : the official journal of World Institute of Pain*, 19(2), 183–195. <https://doi.org/10.1111/papr.12732>

Macuga, K. L., & Frey, S. H. (2012). Neural representations involved in observed, imagined, and imitated actions are dissociable and hierarchically organized. *NeuroImage*, 59(3), 2798–2807. <https://doi.org/10.1016/j.neuroimage.2011.09.083>

Magerl, W., Thalacker, E., Vogel, S., Schleip, R., Klein, T., Treede, R. D., & Schilder, A. (2021). Tenderness of the Skin after Chemical Stimulation of Underlying Temporal and Thoracolumbar Fasciae Reveals Somatosensory Crosstalk between Superficial and Deep Tissues. *Life (Basel, Switzerland)*, 11(5), 370. <https://doi.org/10.3390/life11050370>

Maghami E., Ho A. (2018). *Multidisciplinary Care of the Head and Neck Cancer Patient*. Springer International Publishing; Berlin/Heidelberg, Germany.

Mao, J. J., Wagner, K. E., Seluzicki, C. M., Hugo, A., Galindez, L. K., Sheaffer, H., & Fox, K. R. (2017). Integrating Oncology Massage Into Chemoinfu-

sion Suites: A Program Evaluation. *Journal of oncology practice*, 13(3), e207–e216. <https://doi.org/10.1200/JOP.2016.015081>

McCarthy S, Rickards LD, Lucas N. (2007). Using the concept of ideomotor therapy in the treatment of a patient with chronic neck pain: a single system research design. *Int J Osteopath Med*, 10:104–112.

McKay, J., Nasb, M., & Hafsi, K. (2022). Mechanobiology-based physical therapy and rehabilitation after orthobiologic interventions: a narrative review. *International orthopaedics*, 46(2), 179–188. <https://doi.org/10.1007/s00264-021-05253-5>

McKenney, K., Elder, A. S., Elder, C., & Hutchins, A. (2013). Myofascial release as a treatment for orthopaedic conditions: a systematic review. *Journal of athletic training*, 48(4), 522–527. <https://doi.org/10.4085/1062-6050-48.3.17>

McMillan, H., Barbon, C., Cardoso, R., Sedory, A., Buoy, S., Porsche, C., Savage, K., Mayo, L., & Hutcheson, K. A. (2022). Manual Therapy for Patients With Radiation-Associated Trismus After Head and Neck Cancer. *JAMA otolaryngology-head & neck surgery*, 148(5), 418–425. <https://doi.org/10.1001/jamaoto.2022.0082>

Mense S. (2019). Innervation of the thoracolumbar fascia. *European journal of translational myology*, 29(3), 8297. <https://doi.org/10.4081/ejtm.2019.8297>

Michaleff, Z. A., Lin, C. W., Maher, C. G., & van Tulder, M. W. (2012). Spinal manipulation epidemiology: systematic review of cost effectiveness studies. *Journal of electromyography and kinesiology : official journal of the International Society of Electrophysiological Kinesiology*, 22(5), 655–662. <https://doi.org/10.1016/j.jelekin.2012.02.011>

Minasny B. (2009). Understanding the process of fascial unwinding. *International journal of thera-*

peutic massage & bodywork, 2(3), 10–17. <https://doi.org/10.3822/ijtmb.v2i3.43>

Moloney, E. C., Brunner, M., Alexander, A. J., & Clark, J. (2015). Quantifying fibrosis in head and neck cancer treatment: An overview. *Head & neck*, 37(8), 1225–1231. <https://doi.org/10.1002/hed.23722>

Monument, M. J., Hart, D. A., Salo, P. T., Befus, A. D., & Hildebrand, K. A. (2015). Neuroinflammatory Mechanisms of Connective Tissue Fibrosis: Targeting Neurogenic and Mast Cell Contributions. *Advances in wound care*, 4(3), 137–151. <https://doi.org/10.1089/wound.2013.0509>

Organización Mundial de la Salud. <https://www.who.int/es/>. Published 2021. Accedido octubre 2021.

Ortiz-Comino, L., Fernández-Lao, C., Castro-Martín, E., Lozano-Lozano, M., Cantarero-Villanueva, I., Arroyo-Morales, M., & Martín-Martín, L. (2020). Myofascial pain, widespread pressure hypersensitivity, and hyperalgesia in the face, neck, and shoulder regions, in survivors of head and neck cancer. *Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer*, 28(6), 2891–2898. <https://doi.org/10.1007/s00520-019-05173-6>

Pastor, M. F., Averbek, A. K., Welke, B., Smith, T., Claassen, L., & Wellmann, M. (2016). The biomechanical influence of the deltoid trapezoid fascia on horizontal and vertical acromioclavicular joint stability. *Archives of orthopaedic and trauma surgery*, 136(4), 513–519. <https://doi.org/10.1007/s00402-015-2389-1>

Pattanshetty, R. B., & Patil, S. N. (2022). Role of Manual Therapy for Neck Pain and Quality of Life in Head and Neck Cancer Survivors: A Systematic Review. *Indian journal of palliative care*, 28(1), 99–112. https://doi.org/10.25259/IJPC_10_2021

- Pavan, P. G., Stecco, A., Stern, R., & Stecco, C. (2014). Painful connections: densification versus fibrosis of fascia. *Current pain and headache reports*, 18(8), 441. <https://doi.org/10.1007/s11916-014-0441-4>
- Pérez-Llanes, R., Donoso-Úbeda, E., Meroño-Gallut, J., Lopez-Pina, J. A., & Cuesta-Barriuso, R. (2020). Manual Therapy Effectively Decreases the Frequency of Joint Bleeding Improves Joint Health and Reduces Pain in Hemophilic Elbow Arthropathy: A Prospective Cohort Study. *Journal of rehabilitation medicine. Clinical communications*, 3, 1000035. <https://doi.org/10.2340/20030711-1000035>
- Peuckmann, V., Ekholm, O., Rasmussen, N. K., Groenvold, M., Christiansen, P., Møller, S., Eriksen, J., & Sjøgren, P. (2009). Chronic pain and other sequelae in long-term breast cancer survivors: nationwide survey in Denmark. *European journal of pain (London, England)*, 13(5), 478–485. <https://doi.org/10.1016/j.ejpain.2008.05.015>
- Pilat A. (2015). Myofascial induction approaches. In: Fernández-de-las-Peñas C, Cleland JA, Dommerholt J (Eds.) *Manual Therapy for Musculoskeletal Pain Syndromes of the Upper and Lower Quadrants: An Evidence and Clinical Informed Approach*. London: Elsevier.
- Pilat A. (2022). *Myofascial Induction. An Anatomical Approach*. Handspring Publishing.
- Pinheiro da Silva, F., Moreira, G. M., Zomkowski, K., Amaral de Noronha, M., & Flores Sperandio, F. (2019). Manual Therapy as Treatment for Chronic Musculoskeletal Pain in Female Breast Cancer Survivors: A Systematic Review and Meta-Analysis. *Journal of manipulative and physiological therapeutics*, 42(7), 503–513. <https://doi.org/10.1016/j.jmpt.2018.12.007>
- Pradat, P. F., & Delanian, S. (2013). Late radiation injury to peripheral nerves. *Handbook of clinical neurology*, 115, 743–758. <https://doi.org/10.1016/B978-0-444-52902-2.00043-6>
- Purslow P. (2010). Muscle fascia and force transmission, *J Bodyw Mov Ther*, 14(4):411–417.
- Rao, M. S., & Pattanshetty, R. B. (2022). Effect of myofascial release, stretching, and strengthening on upper torso posture, spinal curvatures, range of motion, strength, shoulder pain and disability, and quality of life in breast cancer survivors. *Physiotherapy research international : the journal for researchers and clinicians in physical therapy*, 27(2), e1939. <https://doi.org/10.1002/pri.1939>
- Rebecca L. Siegel RL, Miller KD, Fuchs HE, Jemal A. (2021). Cancer Statistics, 2021. *CA Cancer J Clin.*, 71:7–33.
- Ringash J. (2015). Survivorship and Quality of Life in Head and Neck Cancer. *J. Clin. Oncol.*, 33:3322–3327. doi: 10.1200/JCO.2015.61.4115.
- Rubinstein S. M. (2008). Adverse events following chiropractic care for subjects with neck or low-back pain: do the benefits outweigh the risks?. *Journal of manipulative and physiological therapeutics*, 31(6), 461–464. <https://doi.org/10.1016/j.jmpt.2008.06.001>
- Sahrmann S. (2017). THE HOW AND WHY OF THE MOVEMENT SYSTEM AS THE IDENTITY OF PHYSICAL THERAPY. *International journal of sports physical therapy*, 12(6), 862–869.
- Sánchez-Jiménez, A., Cantarero-Villanueva, I., Molina-Barea, R., Fernández-Lao, C., Galiano-Castillo, N., & Arroyo-Morales, M. (2014). Widespread pressure pain hypersensitivity and ultrasound imaging evaluation of abdominal area after colon cancer treatment. *Pain medicine (Malden, Mass.)*, 15(2), 233–240. <https://doi.org/10.1111/pme.12281>
- Sanford, N. N., Sher, D. J., Butler, S. S., Xu, X., Ahn, C., Aizer, A. A., & Mahal, B. A. (2019). Prev-

alence of chronic pain among cancer survivors in the United States, 2010-2017. *Cancer*, 125(23), 4310–4318. <https://doi.org/10.1002/cncr.32450>

Schleip R. (2003). Fascial plasticity: a new neurobiological explanation. Part 2. *J Bodyw Mov Ther*, 7:104–116

Schleip, R., Gabbiani, G., Wilke, J., Naylor, I., Hinz, B., Zorn, A., Jäger, H., Breul, R., Schreiner, S., & Klingler, W. (2019). Fascia Is Able to Actively Contract and May Thereby Influence Musculoskeletal Dynamics: A Histochemical and Mechanographic Investigation. *Frontiers in physiology*, 10, 336. <https://doi.org/10.3389/fphys.2019.00336>

Serra-Añó, P., Inglés, M., Bou-Catalá, C., Iraola-Lliso, A., & Espí-López, G. V. (2019). Effectiveness of myofascial release after breast cancer surgery in women undergoing conservative surgery and radiotherapy: a randomized controlled trial. Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer, 27(7), 2633–2641. <https://doi.org/10.1007/s00520-018-4544-z>

Shea MJ. (2007). *Biodynamic Craniosacral Therapy*. Berkeley, California: North Atlantic Books.

Spagnolo, F., Sestak, I., Howell, A., Forbes, J. F., & Cuzick, J. (2016). Anastrozole-Induced Carpal Tunnel Syndrome: Results From the International Breast Cancer Intervention Study II Prevention Trial. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*, 34(2), 139–143. <https://doi.org/10.1200/JCO.2015.63.4972>

Spitz H. (1997). *Nonconscious movements: from mystical messages to facilitated communication*. Lawrence Erlbaum Associates Inc., New Jersey.

Stout, N. L., Santa Mina, D., Lyons, K. D., Robb, K., & Silver, J. K. (2021). A systematic review of rehabilitation and exercise recommendations in

oncology guidelines. *CA: a cancer journal for clinicians*, 71(2), 149–175. <https://doi.org/10.3322/caac.21639>

Straub, J. M., New, J., Hamilton, C. D., Lominska, C., Shnayder, Y., & Thomas, S. M. (2015). Radiation-induced fibrosis: mechanisms and implications for therapy. *Journal of cancer research and clinical oncology*, 141(11), 1985–1994. <https://doi.org/10.1007/s00432-015-1974-6>

Stuiver, M. M., van Wilgen, C. P., de Boer, E. M., de Goede, C. J., Koolstra, M., van Opzeeland, A., Venema, P., Sterken, M. W., Vincent, A., & Dijkstra, P. U. (2008). Impact of shoulder complaints after neck dissection on shoulder disability and quality of life. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*, 139(1), 32–39. <https://doi.org/10.1016/j.otohns.2008.03.019>

Suarez-Rodriguez, V., Fede, C., Pirri, C., Petrelli, L., Loro-Ferrer, J. F., Rodriguez-Ruiz, D., De Caro, R., & Stecco, C. (2022). Fascial Innervation: A Systematic Review of the Literature. *International journal of molecular sciences*, 23(10), 5674. <https://doi.org/10.3390/ijms23105674>

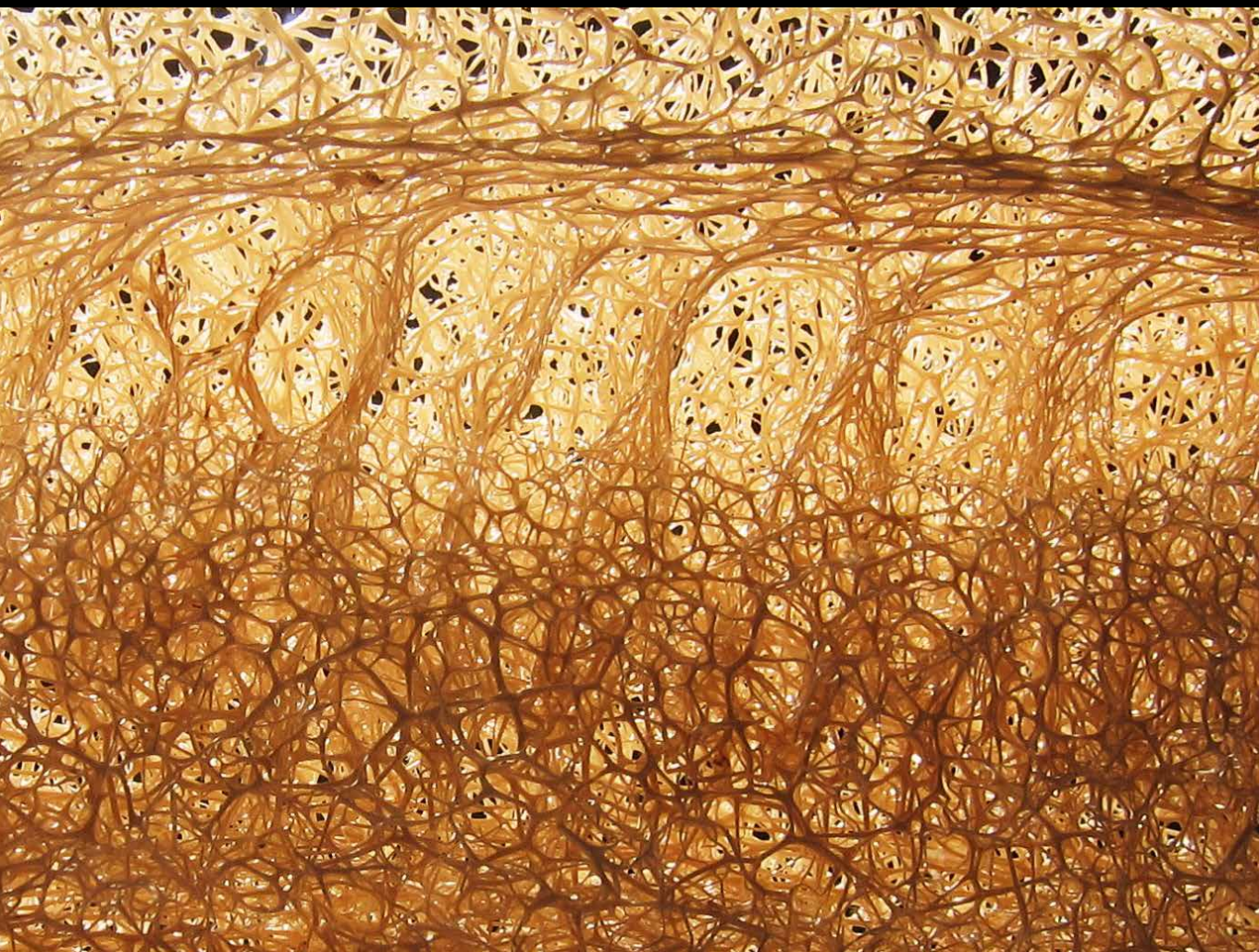
Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: a cancer journal for clinicians*, 71(3), 209–249. <https://doi.org/10.3322/caac.21660>

Tai, Y., Woods, E. L., Dally, J., Kong, D., Steadman, R., Moseley, R., & Midgley, A. C. (2021). Myofibroblasts: Function, Formation, and Scope of Molecular Therapies for Skin Fibrosis. *Biomolecules*, 11(8), 1095. <https://doi.org/10.3390/biom11081095>

Taube, W., Mouthon, M., Leukel, C., Hoogewoud, H. M., Annoni, J. M., & Keller, M. (2015). Brain

- activity during observation and motor imagery of different balance tasks: an fMRI study. *Cortex; a journal devoted to the study of the nervous system and behavior*, 64, 102–114. <https://doi.org/10.1016/j.cortex.2014.09.022>
- Tozzi, P., Bongiorno, D., & Vitturini, C. (2011). Fascial release effects on patients with non-specific cervical or lumbar pain. *Journal of bodywork and movement therapies*, 15(4), 405–416. <https://doi.org/10.1016/j.jbmt.2010.11.003>
- Tozzi, P., Bongiorno, D., & Vitturini, C. (2012). Low back pain and kidney mobility: local osteopathic fascial manipulation decreases pain perception and improves renal mobility. *Journal of bodywork and movement therapies*, 16(3), 381–391. <https://doi.org/10.1016/j.jbmt.2012.02.001>
- Wang, C. J., Huang, E. Y., Hsu, H. C., Chen, H. C., Fang, F. M., & Hsiung, C. Y. (2005). The degree and time-course assessment of radiation-induced trismus occurring after radiotherapy for nasopharyngeal cancer. *The Laryngoscope*, 115(8), 1458–1460. <https://doi.org/10.1097/01.mlg.0000171019.80351.46>
- Wang, H., Schiltenswolf, M., & Buchner, M. (2008). The role of TNF-alpha in patients with chronic low back pain-a prospective comparative longitudinal study. *The Clinical journal of pain*, 24(3), 273–278. <https://doi.org/10.1097/AJP.0b013e31816111d3>
- Wang, T., Zhai, J., Liu, X. L., Yao, L. Q., & Tan, J. B. (2021). Massage Therapy for Fatigue Management in Breast Cancer Survivors: A Systematic Review and Descriptive Analysis of Randomized Controlled Trials. *Evidence-based complementary and alternative medicine : eCAM*, 2021, 9967574. <https://doi.org/10.1155/2021/9967574>
- Ward RC. (2002). Integrated neuromusculoskeletal release and myofascial release. In: Ward RC, editor. *Foundations for Osteopathic Medicine*. 2nd edition (931–65). Philadelphia, Pennsylvania: Lippincott Williams and Wilkins.
- Waters-Banker, C., Dupont-Versteegden, E. E., Kitzman, P. H., & Butterfield, T. A. (2014). Investigating the mechanisms of massage efficacy: the role of mechanical immunomodulation. *Journal of athletic training*, 49(2), 266–273. <https://doi.org/10.4085/1062-6050-49.2.25>
- Wilke, J., Debelle, H., Tenberg, S., Dilley, A., & Maganaris, C. (2020). Ankle Motion Is Associated With Soft Tissue Displacement in the Dorsal Thigh: An *in vivo* Investigation Suggesting Myofascial Force Transmission Across the Knee Joint. *Frontiers in physiology*, 11, 180. <https://doi.org/10.3389/fphys.2020.00180>
- Wilke, J., Krause, F., Vogt, L., & Banzer, W. (2016). What Is Evidence-Based About Myofascial Chains: A Systematic Review. *Archives of physical medicine and rehabilitation*, 97(3), 454–461. <https://doi.org/10.1016/j.apmr.2015.07.023>
- Wilson, M., & Knoblich, G. (2005). The case for motor involvement in perceiving conspecifics. *Psychological bulletin*, 131(3), 460–473. <https://doi.org/10.1037/0033-2909.131.3.460>
- World Confederation for Physical Therapy. WCPT guideline for the development of a system of legislation/regulation/recognition of physical therapists. London, UK: WCPT; 2011. www.wcpt.org/guidelines/regulation-legislation (Accedido 20 Junio 2022)
- Yuan, S. L., Matsutani, L. A., & Marques, A. P. (2015). Effectiveness of different styles of massage therapy in fibromyalgia: a systematic review and meta-analysis. *Manual therapy*, 20(2), 257–264. <https://doi.org/10.1016/j.math.2014.09.003>
- Zhang, C., & Gao, Y. (2012). Finite element analysis of mechanics of lateral transmission of force in single muscle fiber. *Journal of biomechanics*, 45(11), 2001–2006. <https://doi.org/10.1016/j.jbiomech.2012.04.026>

O B J E T I V O S





El objetivo principal de esta Tesis Doctoral fue: demostrar la eficacia de un novedoso programa de IM con procedimientos de UM, para la mejora de la mecanosensibilidad, el dolor y los trastornos del movimiento y la función, como secuelas relacionadas con el tratamiento oncológico en supervivientes de CM y CCC.

Para responder a éste, esta Tesis está organizada en tres estudios, basándose en los siguientes objetivos específicos:

- 1. Estudio I.** Investigar los efectos inmediatos de la UM (frente a placebo como control) sobre el dolor percibido, el rango de movimiento cervical y del hombro, y el estado de ánimo en supervivientes de CM con morbilidad de hombro/brazo. Como objetivo secundario se examinó las relaciones entre las modificaciones del dolor y el rango de movimiento cervical y del hombro en el lado afectado por el CM.
- 2. Estudio II.** Comprobar los efectos a corto plazo de una sola sesión de UM sobre la mecanosensibilidad neuronal a través del rango de movimiento, la reproducción de los síntomas y los umbrales de dolor por presión, y test neurodinámicos del miembro superior, frente a un grupo placebo como control. Como objetivo secundario, determinar la posible influencia o no de las actitudes del paciente hacia el masaje en supervivientes de CM.
- 3. Estudio III.** Determinar los efectos inmediatos de UM sobre el dolor cervical y de hombro, el rango de movimiento cervical y del hombro, la apertura máxima de la boca y la función muscular cervical en supervivientes de CCC con morbilidad de cuello/hombro en comparación con la terapia de onda corta pulsada como placebo.

MATERIAL Y MÉTODOS
RESULTADOS
DISCUSIÓN

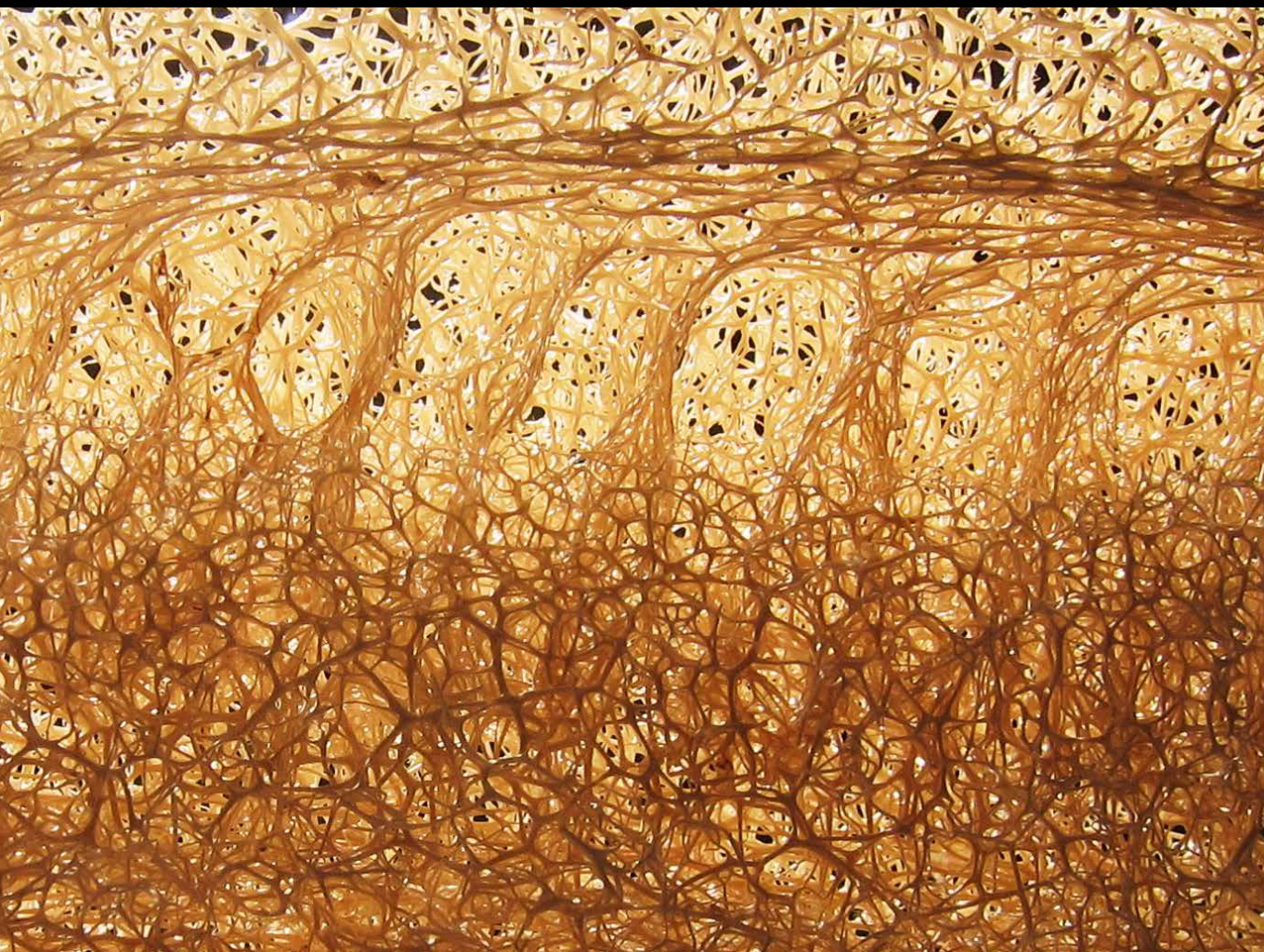




Tabla 1. Resumen de las características de los artículos publicados incluidos en la presente Tesis Doctoral.

Artículo	Diseño	PARTICIPANTES	VARIABLES ESTUDIADAS
Myofascial induction effects on neck-shoulder pain in breast cancer survivors: Randomized, single-blind, placebo-controlled cross-over design	Diseño cruzado, aleatorizado, simple ciego y controlado con placebo	21 supervivientes CM; edad 50.14 $\pm$ 8.81 años; Tiempo desde el tratamiento médico: 13 $\leq$ 12 meses, 8 > 12 meses	Dolor cervical y del hombro (EVA) Ansiedad (EVA) Rango de movimiento activo cervical y del hombro (CROM y goniómetro) Estado de ánimo (POMS)
Effects of a single myofascial induction session on neural mechanosensitivity in breast cancer survivors: a secondary analysis of a crossover study	Diseño cruzado, aleatorizado, simple ciego y controlado con placebo	20 supervivientes CM; edad 51,15 $\pm$ 8,68 años; Tiempo desde el tratamiento médico: 13 $\leq$ 12 meses, 7 > 12 meses	Test neurodinámicos mediano, radial y cubital (goniometría) Umbral de dolor por presión sobre los nervios (algometría electrónica) Actitud del paciente frente al masaje (ATOM)
Myofascial induction therapy improves the sequelae of medical treatment in head and neck cancer survivors: a single-blind, placebo-controlled, randomized cross-over study.	Diseño cruzado, aleatorizado, simple ciego y controlado con placebo	22 supervivientes CCC; edad: 56,55 $\pm$ 12,71 años; Tiempo desde el diagnóstico 26,33 $\pm$ 16,68 meses	Dolor cervical y hombro (EVA) Rango de movimiento activo cervical y del hombro (CROM y goniómetro) Apertura máxima de la boca (calibrador digital) Actividad de los músculos flexores cervicales profundos (Test de resistencia)

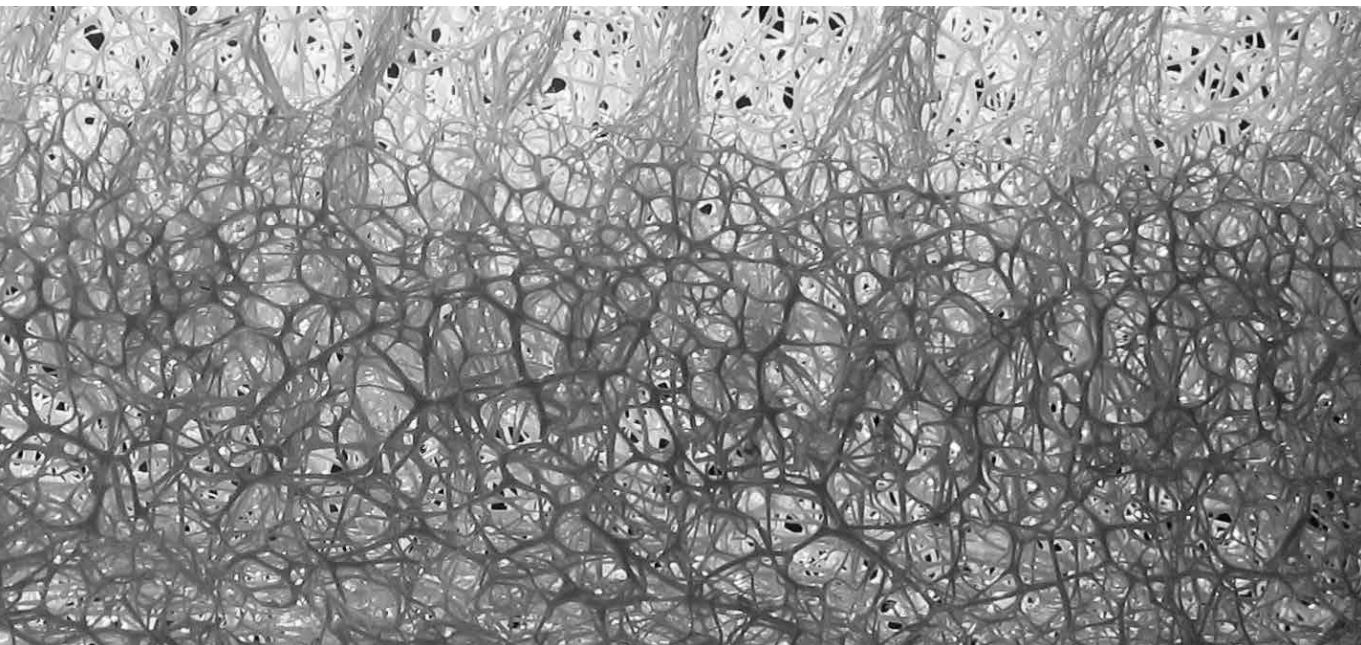
Abreviaturas: CM, cáncer de mama. CCC, cáncer de cabeza y cuello. EVA, escala visual analógica. CROM, cervical range of motion. POMS, Profile of Mood States. ATOM, Attitudes Towards Massage.

ESTUDIO I

MYOFASCIAL INDUCTION EFFECTS
ON NECK-SHOULDER PAIN
IN BREAST CANCER SURVIVORS:
RANDOMIZED, SINGLE-BLIND,
PLACEBO-CONTROLLED CROSS-OVER DESIGN

Archives of Physical Medicine and Rehabilitation (2017)

Castro-Martín, E., Ortiz-Comino, L., Gallart-Aragón, T., Esteban-Moreno, B., Arroyo-Morales, M., & Galiano-Castillo, N. (2017). Myofascial Induction Effects on Neck-Shoulder Pain in Breast Cancer Survivors: Randomized, Single-Blind, Placebo-Controlled Crossover Design. Archives of physical medicine and rehabilitation, 98(5), 832-840. <https://doi.org/10.1016/j.apmr.2016.11.019>





ABSTRACT

Objectives: To investigate the immediate effects of myofascial induction (MI) with placebo electrotherapy as control on perceived pain, cervical/shoulder range of motion (ROM) and mood state in breast cancer survivors (BCSs) with shoulder/arm morbidity. Our secondary objective was to examine the relationships between pain modifications and cervical/shoulder ROM on the side affected by breast cancer.

Design: Randomized, single-blind, placebo-controlled cross-over study.

Setting: Physical therapy laboratory.

Participants: Twenty-one BCSs who had a diagnosis of stage I-IIIa breast cancer and had completed adjuvant therapy (except hormonal treatment).

Intervention: During each session, the BCSs received either an MI (fascial unwinding) intervention focused on the upper limb area following the Pilat approach or placebo pulsed shortwave therapy (control group). Each session lasted 30 minutes, and an adequate wash-out period of 4 weeks between sessions was established.

Main Outcome Measures: The Visual Analogue Scale (VAS) for pain and anxiety, shoulder-cervical goniometry for ROM, the Profile of Mood States (POMS) for psychological distress and the Attitudes Towards Massage (ATOM) Scale were used.

Results: An analysis of covariance (ANCOVA) revealed significant time x group interactions for VAS affected arm ($P=0.031$) but not for VAS cervical ($P=0.332$), VAS non-affected arm ($P=0.698$) or VAS anxiety ($P=0.266$). The ANCOVA

also revealed significant interactions for affected shoulder flexion ($P<0.001$), abduction ($P<0.001$), external rotation ($P=0.004$) and internal rotation ($P=0.001$). Significant interactions for affected cervical rotation ($P=0.022$) and affected cervical lateral flexion ($P=0.038$) were also found. A significant negative correlation was found between changes in VAS affected arm and shoulder/arm internal rotation ROM ($r=-0.46$; $P=0.03$).

Conclusions: A single MI session decreases pain intensity and improves neck-shoulder ROM to a greater degree than placebo electrotherapy for BCSs experiencing pain.

Keywords: Neck; Shoulder; Pain; Breast Cancer; Manual Therapies

INTRODUCTION

Pain is a symptom experienced by 20-65% of breast cancer survivors (BCSs)^{1,2} as a result of surgical damage to sensory nerves³ or complications of radiotherapy^{1,4} or chemotherapy.⁵ Several factors are implicated in the onset of this problem, such as the presence of preoperative pain.⁶

Seven years after oncological surgery, 40-70% of survivors have several range of motion (ROM) restrictions. Age and functioning 6 months after surgery are the best predictors of these ROM restrictions.⁷ These upper limb dysfunctions have a clear influence on quality of life⁸ and the ability to return to work⁹ among BCSs.

Knowledge regarding pain after breast cancer treatment has increased in recent years. Different variations of this disabling symptom have been described. Approximately 45% of pain processes affecting BCSs can be classified as

myofascial pain syndromes.¹⁰ Persistent arm pain causes major interference with daily activities and severe mobility impairments, and it is more strongly associated with axillary lymph node dissection than with other surgical procedures, such as sentinel lymph node biopsy.^{6,11} The profile of survivors who experience shoulder/arm morbidity indicates that younger black survivors, those with a higher body mass index and those with pre-treatment symptoms^{6,12,13} are more likely to experience these symptoms. Independent of subgroup, most patients present with bilateral arm morbidity as a consequence of modifications of shoulder kinematics,¹⁴ and flexion and external rotation ROM and arm strength are principally affected.¹⁵ A clear gap in the research exists with respect to adequate therapeutic approaches for minimizing the impact of arm morbidity in BCSs.

A combination of different physical treatment modalities appears to be a valid approach to treating arm morbidity in BCSs.^{16,17} Different forms of soft tissue mobilization or massage techniques could have a relevant role in multifactorial combinations of physical therapy modalities.^{18,19} Nevertheless, it is unknown which manual procedures should be included in multifactorial physical therapy programmes to achieve better therapeutic results.

Myofascial induction (MI) has been shown to be effective in reducing fatigue²⁰ and optimizing immune responses.²¹ MI improves heart rate variability, mood and immune response in BCSs.²² It has been postulated as a type of soft tissue mobilization that could be useful for treating shoulder morbidity in BCSs.¹⁷ Previous research has demonstrated the ability of MI to improve ROM²³ and reduce pain.²⁴ However, no previous research has evaluated the effect of MI

on shoulder/arm morbidity in BCSs.

The aim of this study was to investigate the immediate effects of MI with placebo electrotherapy as a control on perceived pain, cervical/shoulder ROM and mood state in BCSs with shoulder/arm morbidity. We hypothesized that MI helps normalize ROM and reduce pain. A secondary objective of the study was to examine the relationships between modifications in pain and cervical/shoulder ROM on the side affected by breast cancer.

METHODS

Study Design

We implemented a randomized, single-blind, placebo-controlled cross-over design in this study (ClinicalTrials.gov NCT02859168). This design allowed us to control for possible inter-individual variability in the outcome measures following an approach similar to that used in previous studies.²²

Participants

Twenty-one BCSs were recruited from the Oncology and Breast units of the Virgen de las Nieves Hospital (Granada, Spain) from June 2014 to June 2015. The following eligibility criteria were used: (1) had a diagnosis of breast cancer (stage I-IIIa); (2) were between the ages of 25 and 65 years; and (3) had completed adjuvant therapy (except hormonal treatment). Patients were excluded if: (1) had cancer recurrence; (2) had suffered trauma or surgery in the cervical, thoracic or upper limb areas not related to cancer in the last 6 months; or (3) had not medical clearance for participation.

Ethical issues

The study was approved by the ethics committee of The University of Granada (FIS PI10/02749-02764) and was carried out according to the guidelines established by the Helsinki Declaration²⁵ and Law 14/2007 on Biomedical Research.²⁶ All enrolled participants gave their informed consent.

Sample size

Sample size estimation was based on a previous study on the effectiveness of MI for treating chronic pain.²⁷ We defined perceived pain using the visual analogue scale (VAS) score as the primary outcome. The sample size was determined using the following criteria: 80% power to detect a mean difference of 1.5 points with a standard deviation of 3 points, a type 1 error (α) of 7.5%, and a type 2 error (β) of 20%. This power calculation resulted in 20 patients in total and therefore 20 patients for each study group (MI or placebo). To accommodate expected drop-outs before study completion, a total of 21 participants were recruited. The study ended when the sample size was reached.

Study protocol

The participants completed 2 sessions (conducted at the same time of the day) in the physical therapy laboratory, separated by a 4-week interval. All the sessions took place between 10 and 12 AM to avoid possible circadian rhythm-induced variations, as recommended by a previous study of the physiological effects of MI.²⁸ The patients were asked to avoid exercise the day before the study and were instructed not to consume food, caffeine, or alcoholic drinks during the 3 hours preceding the session. A coin flip by a clinician who was blinded to the assessment

and outcomes was used to randomly assign the order of the interventions (MI or placebo). All the sessions took place at a physical therapy laboratory with a thermostatically controlled temperature (20°-22°C).

Interventions

During each experimental session, the patients received an MI (fascial unwinding) (Figure 1) intervention that focused on the upper limb area for 30 minutes (duration adapted to the patient's tissue response) using the Pilat approach.^{29,30} The placebo session consisted of 30 minutes of unplugged pulsed shortwave therapy. The participants heard a sound indicating that the device was starting, but then the device was unplugged. Both interventions were administered by a therapist with more than 18 years of experience in manual therapy and more than 5 years of experience treating BCSs. An adequate wash-out period of 4 weeks between the 2 sessions was established.



Fig 1. Unwinding maneuver description. Slight stimulation is provided while the patient rests the limb.

Outcome measures

Visual Analogue Scale

The VAS is one of the most commonly used instruments to measure pain³¹ and anxiety³² in different populations, including those with breast cancer. The VAS has been widely used and has been shown to be reliable and valid.^{33,34}

Goniometry

We used a plastic universal goniometer with two adjustable overlapping arms to objectively measure the active ROM of the shoulder joint. The participant's position for the measurement of active flexion, abduction, and external and internal rotation was based on guidelines established by Norkin & White.³⁵ The intra-rater reliability of this method is excellent, with an intraclass correlation coefficient (ICC) ≥ 0.94 for all assessed movements.³⁶ To measure the active ROM of the cervical joints, we used a cervical goniometric device manufactured by Performance Attainment Associates (St Paul, MN, USA).⁹ Active ROM was recorded as the total ROM for flexion, extension, lateral flexion and rotation. The participants were asked to sit comfortably on a chair with both feet on the floor (hips and knees at 90°) and the buttocks positioned against the back of the chair.³⁷ The intratester reliability of the cervical goniometer ranges from 0.7 to 0.9.^{38,39}

Mood state

The Profile of Mood States (POMS) questionnaire is a measure of psychological distress that has been widely used,⁴⁰ including for breast cancer patients.²² The Spanish version was used in this study.⁴¹ This questionnaire contains 65

items that assess mood state and are grouped into six subscales: tension-anxiety, depression-dejection, anger-hostility, vigour-activity, fatigue-inertia and confusion-bewilderment. The reliability of the Spanish version of the POMS is high (Cronbach's α 0.76-0.91).⁴¹

Attitudes Towards Massage (ATOM) Scale

This scale has been used in previous studies with samples of BCSs.^{22,42} The ATOM is a nine-item measure of overall attitude towards massage comprising the 'Massage as Healthful' and the 'Massage as Pleasant' subscales. Both subscales are reliable (Cronbach's α >0.70 and >0.80 , respectively).⁴³

Statistical analysis

Descriptive data analysis was performed for all the participants involved in the study. The mean $\pm$ SD (95% CI) was calculated for each variable. The Kolmogorov-Smirnov test was applied to test the hypothesis of normality for all variables. Between-group differences at baseline were analysed using *t* tests (continuous variables). A 2-way repeated-measures analysis of covariance (ANCOVA) with intervention (experimental, placebo) as the between-group variable, time (pre-post) as the within-group variable, and the ATOM subscale scores as covariates was used to examine the effects of the interventions, as recommended in previous research.²² An ANCOVA analysis was performed for each dependent variable. The main hypothesis of interest was the time $\times$ group interaction. If a significant interaction was identified, pairwise comparisons were performed to determine whether the between-group differences in change scores were statistically significant. To study the relationship between changes in

perceived pain and ROM, the Pearson correlation coefficient was used. A P -value <0.05 was considered statistically significant. IBM SPSS Statistics 21 (IBM Corporation, Armonk, NY)^b was used for all the analyses.

RESULTS

A total of 21 BCSs with a mean age of 50.14 ± 8.81 years participated in this study (Table 1). None of the patients had received rehabilitation treatment. The ATOM subscale scores did not influence the results.

Effects of MI on VAS

The ANCOVA revealed a significant time $\times$ group interaction for VAS affected arm ($F=5.021$, $P=0.031$) but not for VAS cervical ($F=0.963$, $P=0.332$), VAS non-affected arm ($F=0.159$, $P=0.698$) or VAS anxiety ($F=1.274$, $P=0.266$) (Table 2). Pairwise comparisons revealed that the BCSs in the experimental group experienced a significantly greater VAS affected arm decrease after the manual therapy intervention compared with the BCSs in the placebo session group ($P<0.004$).

Effects of MI on shoulder goniometry

The ANCOVA revealed a significant time $\times$ group interaction for affected flexion ($F=25.227$, $P<0.001$), affected abduction ($F=47.029$, $P<0.001$), affected external rotation ($F=9.198$, $P=0.004$) and affected internal rotation ($F=12.648$, $P=0.001$) but not for non-affected flexion ($F=0.072$, $P=0.790$), non-affected abduction ($F=0.580$, $P=0.451$), non-affected external

rotation ($F=0.469$, $P=0.497$) or non-affected internal rotation ($F=1.765$, $P=0.192$) (Table 3). Pairwise comparisons revealed that affected abduction ($P<0.004$) improved significantly after the manual therapy intervention but remained similar ($P>0.05$) after placebo intervention. Additionally, the affected flexion of the BCSs ($P<0.004$) improved significantly after the manual therapy intervention but worsened ($P>0.05$) after the placebo intervention. Finally, affected external and internal rotation improved significantly ($P<0.01$) after MI.

Effects of MI on cervical goniometry

The ANCOVA revealed a significant time $\times$ group interaction for affected rotation ($F=5.703$, $P=0.022$) and affected lateral flexion ($F=4.595$, $P=0.038$) but not for flexion ($F=0.419$, $P=0.521$), extension ($F=3.114$, $P=0.085$), non-affected rotation ($F=2.409$, $P=0.129$) or non-affected lateral flexion ($F=0.324$, $P=0.572$) (Table 4). Pairwise comparisons indicated that affected rotation ($P=0.04$) and affected lateral flexion ($P=0.012$) improved significantly for the BCSs after the MI intervention. However, the ROM remained the same ($P>0.05$) after the placebo intervention.

Effects of MI on POMS

The ANCOVA found no significant time $\times$ group interactions for total mood disturbance ($F=0.008$, $P=0.929$), tension-anxiety ($F=0.293$, $P=0.591$), depression-dejection ($F=0.202$, $P=0.656$), anger-hostility ($F=0.160$, $P=0.691$), vigour-activity ($F=0.146$, $P=0.704$), fatigue-inertia ($F=0.845$, $P=0.364$) and confusion-bewilderment ($F<0.001$, $P=1.000$) (Table 5).

Table 1. Sociodemographic and clinical characteristics.

Variable	BCSs (n = 21)
Age (years), mean (SD)	50.14 (8.81)
Time since surgery, n (%)	
≤12 months	13 (61.90)
>12 months	8 (38.10)
Marital status, n (%)	
Single	1 (4.80)
Married	19 (90.50)
Divorced	1 (4.80)
Educational level, n (%)	
Basic level	6 (28.60)
Medium level	6 (28.60)
High level	9 (42.90)
Employment status, n (%)	
Housewife	6 (28.60)
Employed	3 (14.30)
Medical leave	6 (28.60)
Unemployed (by illness)	6 (28.60)
Cancer stage, n (%)	
I	5 (23.80)
II	15 (71.40)
IIIA	1 (4.80)
Type of surgery, n (%)	
Lumpectomy	3 (14.30)
Quadrantectomy	7 (33.30)
Unilateral mastectomy	9 (42.90)
Mastectomy & lymphadenectomy	2 (9.50)
Medical treatment, n (%)	
Radiotherapy	0
Chemotherapy	0
Radiotherapy & chemotherapy	21 (100)
Menopause, n (%)	
Pre-menopause	3 (14.30)
Post-menopause	18 (85.70)

Table 2. Pre-intervention, post-intervention and change scores for the VAS.

<i>n</i> = 21	MI session	Placebo session
VAS cervical		
Pre-intervention	5.62 ± 2.54 (95% CI 4.46; 6.77)	4.67 ± 3.02 (95% CI 3.29; 6.04)
Post-intervention	3.71 ± 2.51 (95% CI 2.57; 4.86)	3.33 ± 2.67 (95% CI 2.12; 4.55)
Pre-post differences	-1.91 ± 2.00 (95% CI -2.81; -0.99)	-1.34 ± 1.77 (95% CI -2.14; -0.53)
VAS affected arm		
Pre-intervention	4.90 ± 2.62 (95% CI 3.71; 6.10)	3.95 ± 2.01 (95% CI 3.04; 4.87)
Post-intervention	2.62 ± 2.42 (95% CI 1.52; 3.72)	2.95 ± 2.22 (95% CI 1.94; 3.96)
Pre-post differences	-2.28 ± 2.47 (95% CI -3.41; -1.16)*	-1.00 ± 0.89 (95% CI -1.41; -0.59)
VAS non-affected arm		
Pre-intervention	1.57 ± 2.27 (95% CI 0.54; 2.60)	1.24 ± 1.95 (95% CI 0.35; 2.12)
Post-intervention	1.33 ± 2.22 (95% CI 0.32; 2.34)	0.90 ± 1.79 (95% CI 0.09; 1.72)
Pre-post differences	-0.24 ± 1.18 (95% CI -0.77; 0.30) †	-0.34 ± 1.32 (95% CI -0.93; 0.27) †
VAS anxiety		
Pre-intervention	4.00 ± 2.19 (95% CI 3.00; 5.00)	3.52 ± 2.71 (95% CI 2.29; 4.76)
Post-intervention	1.81 ± 2.16 (95% CI 0.83; 2.79)	1.95 ± 2.27 (95% CI 0.92; 2.98)
Pre-post differences	-2.19 ± 1.43 (95% CI -2.84; -1.54)	-1.57 ± 2.06 (95% CI -2.51; -0.63)

Data are shown as mean ± SD (95% confidence interval for the mean) at pre-intervention and post-intervention and as mean differences ± SD (95% confidence interval for the difference) for pre-post differences. Significant time x group interaction. (ANCOVA test, **P* < 0.05). †Variable transformed to natural logarithm (ln). CI: Confidence interval.

Table 3. Pre-intervention, post-intervention and change scores for shoulder goniometry.

<i>n</i> = 21	MI session	Placebo session
Affected flexion (°)		
Pre-intervention	135.50 ± 25.52 (95% CI 123.88; 147.12)	139.69 ± 20.96 (95% CI 130.15; 149.23)
Post-intervention	147.52 ± 26.89 (95% CI 135.28; 159.76)	137.21 ± 21.52 (95% CI 127.42; 147.01)
Pre-post differences	12.02 ± 7.21 (95% CI 8.74; 15.31) [†]	-2.48 ± 11.09 (95% CI -7.52; 2.57)
Non-affected flexion (°)		
Pre-intervention	162.90 ± 11.18 (95% CI 157.81; 167.99)	165.50 ± 9.22 (95% CI 161.30; 169.70)
Post-intervention	160.59 ± 25.76 (95% CI 148.87; 172.32)	161.40 ± 19.50 (95% CI 152.53; 170.28)
Pre-post differences	-2.31 ± 25.18 (95% CI -13.76; 9.15)	-4.10 ± 17.28 (95% CI -11.96; 3.77)
Affected abduction (°)		
Pre-intervention	103.67 ± 23.55 (95% CI 92.94; 114.39)	107.00 ± 22.13 (95% CI 96.92; 117.07)
Post-intervention	127.83 ± 28.42 (95% CI 114.90; 140.77)	106.59 ± 23.64 (95% CI 95.83; 117.36)
Pre-post differences	24.16 ± 15.41 (95% CI 17.15; 31.18) [†]	-0.41 ± 5.65 (95% CI -2.98; 2.17)
Non-affected abduction (°)		
Pre-intervention	144.00 ± 30.99 (95% CI 129.89; 158.11)	143.69 ± 24.95 (95% CI 132.33; 155.05)
Post-intervention	147.78 ± 28.85 (95% CI 134.65; 160.92)	145.26 ± 29.41 (95% CI 131.87; 158.65)
Pre-post differences	3.78 ± 10.58 (95% CI -1.03; 8.60)	1.57 ± 8.11 (95% CI -2.12; 5.26)
Affected external rotation (°)		
Pre-intervention	58.76 ± 26.11 (95% CI 46.88; 70.65)	60.02 ± 23.63 (95% CI 49.27; 70.78)
Post-intervention	70.55 ± 22.58 (95% CI 60.27; 80.82)	62.74 ± 23.25 (95% CI 52.16; 73.32)
Pre-post differences	11.79 ± 11.30 (95% CI 6.64; 16.93) [*]	2.72 ± 7.76 (95% CI -0.82; 6.24)
Non-affected external rotation(°)		
Pre-intervention	79.52 ± 21.60 (95% CI 69.69; 89.35)	78.59 ± 20.07 (95% CI 69.46; 87.73)
Post-intervention	81.93 ± 18.90 (95% CI 73.32; 90.53)	79.90 ± 18.85 (95% CI 71.32; 88.48)
Pre-post differences	2.41 ± 6.29 (95% CI -0.46; 5.27)	1.31 ± 3.76 (95% CI -0.40; 3.02)
Affected internal rotation (°)		
Pre-intervention	69.45 ± 17.72 (95% CI 61.38; 77.52)	70.50 ± 15.29 (95% CI 63.54; 77.46)
Post-intervention	80.02 ± 12.40 (95% CI 74.38; 85.67)	71.93 ± 14.50 (95% CI 65.33; 78.53)
Pre-post differences	10.57 ± 10.49 (95% CI 5.80; 15.34) [*]	1.43 ± 5.36 (95% CI -1.01; 3.87)
Non-affected internal rotation (°)		
Pre-intervention	77.57 ± 13.50 (95% CI 71.42; 83.72)	78.50 ± 9.97 (95% CI 73.96; 83.04)
Post-intervention	79.62 ± 14.75 (95% CI 72.90; 86.33)	78.12 ± 10.85 (95% CI 73.18; 83.06)
Pre-post differences	2.05 ± 5.03 (95% CI -0.24; 4.34)	-0.38 ± 6.69 (95% CI -3.43; 2.67)

Data are shown as mean ± SD (95% confidence interval for the mean) at pre-intervention and post-intervention and as mean differences ± SD (95% confidence interval for the difference) for pre-post differences. Significant time x group interaction (ANCOVA test, ^{*}*P* < 0.05 [†]*P* < 0.001). CI: Confidence interval.

Table 4. Pre-intervention, post-intervention and change scores for cervical goniometry.

<i>n</i> = 21	MI session	Placebo session
Flexion (°)		
Pre-intervention	53.81 ± 13.53 (95% CI 47.65; 59.97)	53.17 ± 12.63 (95% CI 47.42; 58.92)
Post-intervention	55.21 ± 12.54 (95% CI 49.51; 60.92)	53.38 ± 11.25 (95% CI 48.26; 58.50)
Pre-post differences	1.40 ± 6.57 (95% CI -1.59; 4.40)	0.21 ± 5.28 (95% CI -2.19; 2.62)
Extension (°)		
Pre-intervention	46.81 ± 14.56 (95% CI 40.18; 53.44)	45.28 ± 12.66 (95% CI 39.52; 51.05)
Post-intervention	51.52 ± 13.60 (95% CI 45.33; 57.71)	45.95 ± 13.10 (95% CI 39.99; 51.91)
Pre-post differences	4.71 ± 9.13 (95% CI 0.56; 8.87)	0.67 ± 5.22 (95% CI -1.71; 3.04)
Affected rotation (°)		
Pre-intervention	61.14 ± 13.55 (95% CI 54.97; 67.31)	57.90 ± 15.55 (95% CI 50.83; 64.98)
Post-intervention	68.75 ± 12.18 (95% CI 63.21; 74.30)	57.78 ± 14.69 (95% CI 51.10; 64.47)
Pre-post differences	7.61 ± 12.35 (95% CI 1.99; 13.23)*	-0.12 ± 8.21 (95% CI -3.86; 3.62)
Non-affected rotation (°)		
Pre-intervention	62.07 ± 14.23 (95% CI 55.59; 68.55)	60.81 ± 12.19 (95% CI 55.26; 66.36)
Post-intervention	66.14 ± 12.99 (95% CI 60.23; 72.05)	61.78 ± 12.10 (95% CI 56.28; 67.29)
Pre-post differences	4.07 ± 6.80 (95% CI 0.98; 7.17)	0.97 ± 6.11 (95% CI -1.80; 3.75)
Affected lateral flexion (°)		
Pre-intervention	36.02 ± 6.52 (95% CI 33.06; 38.99)	37.36 ± 7.62 (95% CI 33.89; 40.82)
Post-intervention	40.81 ± 9.79 (95% CI 36.35; 45.26)	37.78 ± 7.09 (95% CI 34.56; 41.01)
Pre-post differences	4.79 ± 6.62 (95% CI 1.77; 7.80)*	0.42 ± 6.55 (95% CI -2.55; 3.41)
Non-affected lateral flexion (°)		
Pre-intervention	34.98 ± 5.52 (95% CI 32.46; 37.49)	35.40 ± 7.56 (95% CI 31.96; 38.85)
Post-intervention	38.88 ± 7.63 (95% CI 35.40; 42.36)	38.38 ± 8.11 (95% CI 34.69; 42.07)
Pre-post differences	3.90 ± 5.29 (95% CI 1.49; 6.31)	2.98 ± 5.27 (95% CI 0.58; 5.37)

Data are shown as mean ± SD (95% confidence interval for the mean) at pre-intervention and post-intervention and as mean differences ± SD (95% confidence interval for the difference) for pre-post differences. Significant time x group interaction (ANCOVA test, **P* < 0.05). CI: Confidence interval.

Table 5. Pre-intervention, post-intervention and change scores for POMS.

<i>n</i> = 21	MI session	Placebo session
Total Mood Disturbance		
Pre-intervention	-16780.95 ± 4576.53 (95% CI -18864.16; -14697.74)	-17423.81 ± 4917.10 (95% CI -19662.05; -15185.57)
Post-intervention	-14733.33 ± 4127.75 (95% CI -16612.26; -12854.40)	-15447.62 ± 4206.26 (95% CI -17362.28; -13532.95)
Pre-post differences	2047.62 ± 1677.38 (95% CI 1284.08; 2811.15)	1976.19 ± 3225.35 (95% CI 508.03; 3444.35)
Tension-anxiety		
Pre-intervention	40.19 ± 9.18 (95% CI 36.01; 44.37)	42.14 ± 11.97 (95% CI 36.69; 47.59)
Post-intervention	34.28 ± 7.22 (95% CI 31.00; 37.57)	34.76 ± 7.82 (95% CI 31.20; 38.32)
Pre-post differences	-5.91 ± 6.95 (95% CI -9.07; -2.74)	-7.38 ± 10.38 (95% CI -12.11; -2.65)
Depression-dejection		
Pre-intervention	46.57 ± 10.18 (95% CI 41.94; 51.20)	46.57 ± 9.48 (95% CI 42.26; 50.89)
Post-intervention	42.90 ± 8.73 (95% CI 38.93; 46.88)	43.52 ± 9.20 (95% CI 39.33; 47.71)
Pre-post differences	-3.67 ± 3.50 (95% CI -5.26; -2.07)	-3.05 ± 5.26 (95% CI -5.44; -0.65)
Anger-hostility		
Pre-intervention	46.28 ± 10.21 (95% CI 41.64; 50.93)	48.48 ± 11.71 (95% CI 43.15; 53.80)
Post-intervention	42.09 ± 9.23 (95% CI 37.89; 46.30)	43.48 ± 9.43 (95% CI 39.18; 47.77)
Pre-post differences	-4.19 ± 5.00 (95% CI -6.46; -1.92)	-5.00 ± 7.80 (95% CI -8.55; -1.45)
Vigour-activity		
Pre-intervention	51.71 ± 9.50 (95% CI 47.39; 56.04)	50.38 ± 9.09 (95% CI 46.24; 54.52)
Post-intervention	50.52 ± 9.98 (95% CI 45.98; 55.07)	48.38 ± 9.69 (95% CI 43.97; 52.79)
Pre-post differences	-1.19 ± 7.20 (95% CI -4.47; 2.09)	-2.00 ± 6.50 (95% CI -4.96; 0.96)
Fatigue-inertia		
Pre-intervention	47.48 ± 10.37 (95% CI 42.75; 52.20)	47.76 ± 11.39 (95% CI 42.58; 52.94)
Post-intervention	41.62 ± 9.34 (95% CI 37.37; 45.87)	43.24 ± 10.62 (95% CI 38.40; 48.07)
Pre-post differences	-5.86 ± 4.19 (95% CI -7.76; -3.95)	-4.52 ± 5.16 (95% CI -6.87; -2.17)
Confusion-bewilderment		
Pre-intervention	39.00 ± 8.65 (95% CI 35.06; 42.94)	39.67 ± 8.89 (95% CI 35.62; 43.71)
Post-intervention	36.95 ± 8.37 (95% CI 33.14; 40.76)	37.62 ± 8.56 (95% CI 33.72; 41.52)
Pre-post differences	-2.05 ± 3.94 (95% CI -3.84; -0.25)	-2.05 ± 5.45 (95% CI -4.53; 0.43)

Data are shown as mean ± SD (95% confidence interval for the mean) at pre-intervention and post-intervention and as mean differences ± SD (95% confidence interval for the difference) for pre-post differences. CI: Confidence interval.

RELATIONSHIP BETWEEN CHANGES IN PERCEIVED PAIN AND ROM AFTER MI

A significant negative correlation between changes in the affected arm VAS and shoulder/arm internal rotation ROM was found ($r=-0.46$; $P=0.03$); the lower the intensity of the perceived

shoulder pain was, the higher the increase in the ROM of the internal rotation of the shoulder was (Figure 2).

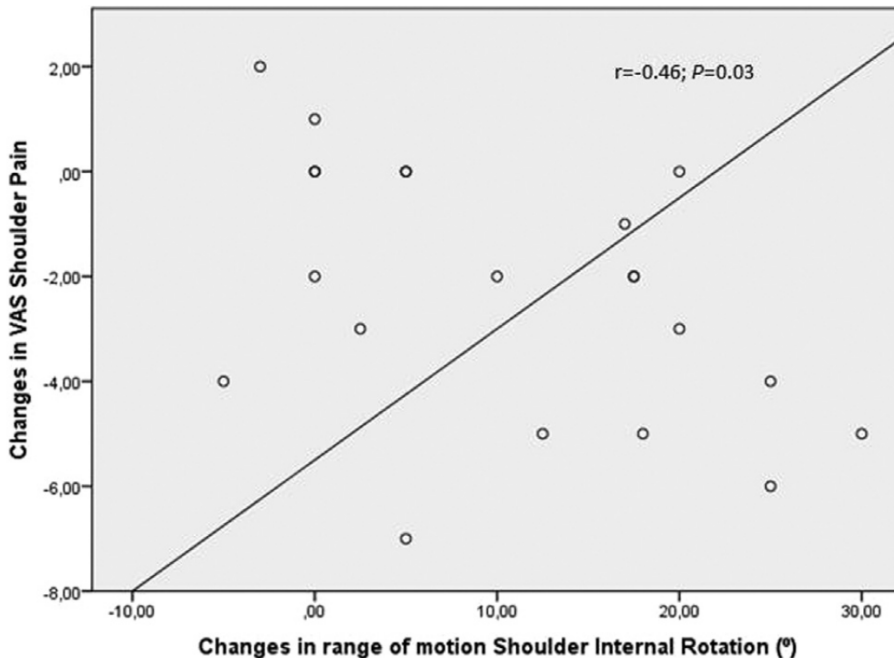


Fig 2. Relationship between perceived shoulder pain and shoulder ROM in internal rotation.

DISCUSSION

In response to the objective of this study, we found a significantly greater decrease in the pain intensity of the arm affected by oncological processes and partial improvement in neck and shoulder mobility immediately after a single MI session in BCSs. We found a relationship between improvement in shoulder pain and internal rotation ROM. These effects were not influenced by the patient's attitude towards this procedure. No changes in mood states were observed immediately after the applied treatment.

One of the principal findings of this study was the ability of one MI manoeuvre to reduce a patient's VAS score and thus increase the minimum clinically important difference needed to elicit relevant changes in shoulder pain intensity.⁴⁴ Different therapeutic modalities, such as multimodal treatments including physical therapy, have been reported to be effective for reducing shoulder pain.^{17,23} One major component of these multimodal treatments in the clinical setting has typically been manual therapy. Several recent studies have reported the positive effects

of a single session using manual or instrumental procedures for alleviating shoulder pain in BCSs.⁴⁵ A recent systematic review claimed that well-designed studies are needed to assess the potential effects of MI on upper limb impairment in breast cancer patients.¹⁷ The current preliminary study could satisfy this need and support the integration of specific MI procedures into the standard treatments for upper limb impairment in BCSs.

Another relevant finding of this study was the marked improvement in abduction, flexion and external and internal rotation observed in the MI group. The kinematics of the shoulder joint are affected by different oncological treatment choices, such as surgery, because of soft tissue restrictions.⁴⁶ The MI procedure used in this study impacted some of the aspects of shoulder ROM that are most often affected by oncological treatment.^{47,48} The unwinding procedure used in this study appears to produce a neurobiological response that could have self-regulation properties.³⁰ These self-regulation properties could be the basis of the more normalized ROM observed immediately after the treatment.

Curiously, the cervical ROM of the affected side rotation and lateral flexion improved with the treatment, but no effects were observed in the other aspects of cervical ROM that were explored. Cervical ROM restrictions could be treated with procedures similar to those used for the general population.⁴⁹ Based on these results, MI could be added to the various manual therapies that have a demonstrated ability to improve movement restrictions in BCSs.⁴⁵ The cervical and shoulder areas have a close relationship, and it is therefore plausible that mechanisms similar to those used in the shoulder area could be involved in cervical ROM improvements.

The mood results reported in this study do not support the possible effects of MI on the psy-

chological state of BCSs. A previous study by our research group²² reported results that disagree with these new findings. Nevertheless, this apparent discrepancy could be explained by the more local effect of the shoulder area treatment used in the present study, which may not stimulate the parasympathetic nervous system in the manner required to elicit the psychological effects of MI.⁵⁰

To the best of our knowledge, this study is one of the first to focus on a unique and specific MI manoeuvre: unwinding. This procedure has been used for decades by various manual therapy practitioners,⁵¹ but there are no existing studies explaining its mechanism of action. The results of this study contribute to the research on this procedure partially confirm the claims of ancient manual therapy books that unwinding can reduce musculoskeletal pain and allow greater ROM,³⁰ especially the more severely affected ROM in the growing population of BCSs. Several models have been postulated to explain how unwinding works in patients, including the ideomotor,⁵² the neurobiological⁵³ and the mixed model.³⁰ It is difficult to frame the results of this study using only one of these theories. However, from a more qualitative perspective of the results, a representative number of patients explained that the practitioner-guided movements to find areas that allowed ease of movement and freedom from pain were associated with a stretching sensation. The contraindications of MI are similar to those of any manual therapy approach, although a few should be mentioned specifically here: aneurysm, systemic disease, inflammatory soft tissue processes during the acute phase, acute circulatory deficiency, advanced diabetes or anticoagulant treatment.⁵⁴

The relationship between improved shoulder pain and increased internal rotation ROM found

in the present study could indicate the importance of increased movement during the ROM normalization process in the shoulder area of BCSs. A recent study shows that the pectoralis major area, one of the most important internal rotators of the shoulder, is the shoulder-cervical region most affected by pain.⁵⁵ It is plausible that improving the ease of a particularly affected aspect of ROM, such as internal rotation, could have elicited a reduction in shoulder pain in this study.

The absence of mood effects after treatment indicated that unwinding could elicit a local response, in contrast to other protocols used in previous studies by our research groups that elicited more MI general effects in healthy people^{20,21} or in a population similar to that of the present study.²²

Study limitations

This study explored the short-term effects of the unwinding manoeuvre, and it is possible that the effects reported in this study could be modified by subsequent sessions, thereby changing these results in the long-term. The therapist who performed the intervention had significant experience with this type of procedure; it is therefore possible that a modification of the results could occur with other practitioners, which could affect the generalizability of the results. Future studies need to address the predisposing factors of pain and ROM restrictions experienced by BCSs. Finally, the adequate but reduced sample size with a cross-over design used in this study may have reduced the inter-individual differences of the participants; therefore, future studies should use a different design to study the long-term effects of these preliminary findings.

CONCLUSIONS

A single MI manoeuvre produces a greater decrease in pain intensity and improved neck-shoulder ROM but does not affect mood in BCSs suffering from cervical-shoulder pain.

LIST OF ABBREVIATIONS

ANCOVA	Analysis of covariance
ATOM	Attitudes Towards Massage Scale
BCSs	Breast cancer survivors
ICC	Intraclass correlation coefficient
MI	Myofascial induction
POMS	Profile of Mood States
ROM	Range of motion
VAS	Visual Analogue Scale

Supported by a research project grant (FIS PI10/02749-02764) from the Health Institute Carlos III and PN IpDpI 2008e2011 (FEDER funds); by a grant (Program FPU AP2010-6075) from the Education Ministry, Madrid, Spanish Government; and by the Andalusian Health Service, Junta de Andalucía (grant no. PI-0457-2010).

Clinical Trial Registration No.: [NCT02859168](#).

Disclosures: none.

REFERENCES

1. Amichetti M. & Caffo O. (2003) Pain after quadrantectomy and radiotherapy for early-stage breast cancer: incidence, characteristics and influence on quality of life. Results from a retrospective study. *Oncology* 65, 23-28.
2. Caffo O., Amichetti M., Ferro A., Lucenti A., Valduga F. & Galligioni E. (2003) Pain and quality of life after surgery for breast cancer. *Breast Cancer Res Treat* 80, 39-48.
3. Wilke L.G., McCall L.M., Posther K.E., Whitworth P.W., Reintgen D.S., Leitch A.M., Gabram S.G., Lucci A., Cox C.E., Hunt K.K., Herndon J.E. & Giuliano A.E. (2006) Surgical complications associated with sentinel lymph node biopsy: results from a prospective international cooperative group trial. *Ann Surg Oncol* 13, 491-500.
4. Poleshuck E.L., Katz J., Andrus C.H., Hogan L.A., Jung B.F., Kulick D.I. & Dworkin R.H. (2006) Risk factors for chronic pain following breast cancer surgery: a prospective study. *J Pain* 7, 626-634.
5. Argyriou A.A., Polychronopoulos P., Koutras A., Xiros N., Petsas T., Argyriou K., Kalofonos H.P. & Chroni E. (2007) Clinical and electrophysiological features of peripheral neuropathy induced by administration of cisplatin plus paclitaxel-based chemotherapy. *Eur J Cancer Care (Engl)* 16, 231-237.
6. Langford D.J., Schmidt B., Levine J.D., Abrams G., Elboim C., Esserman L., Hamolsky D., Mastick J., Paul S.M., Cooper B., Kober K., Dodd M., Dunn L., Aouizerat B. & Miaskowski C. (2015) Preoperative Breast Pain Predicts Persistent Breast Pain and Disability After Breast Cancer Surgery. *J Pain Symptom Manage* 49, 981-994.
7. Kootstra J.J., Dijkstra P.U., Rietman H., De Vries J., Baas P., Geertzen J.H., Hoekstra H.J. & Hoekstra-Weebers J.E. (2013) A longitudinal study of shoulder and arm morbidity in breast cancer survivors 7 years after sentinel lymph node biopsy or axillary lymph node dissection. *Breast Cancer Res Treat* 139, 125-134.
8. Assis M.R., Marx A.G., Magna L.A. & Ferrigno I.S. (2013) Late morbidity in upper limb function and quality of life in women after breast cancer surgery. *Braz J Phys Ther* 17, 236-243.
9. Rietman J.S., Dijkstra P.U., Hoekstra H.J., Eisma W.H., Szabo B.G., Groothoff J.W. & Geertzen J.H. (2003) Late morbidity after treatment of breast cancer in relation to daily activities and quality of life: a systematic review. *Eur J Surg Oncol* 29, 229-238.
10. Torres Lacomba M., Mayoral del Moral O., Coperias Zazo J.L., Gerwin R.D. & Goñi A.Z. (2010) Incidence of myofascial pain syndrome in breast cancer surgery: a prospective study. *Clin J Pain* 26, 320-325.
11. Verbelen H., Gebruers N., Eeckhout F.M., Verlinden K. & Tjalma W. (2014) Shoulder and arm morbidity in sentinel node-negative breast cancer patients: a systematic review. *Breast Cancer Res Treat* 144, 21-31.
12. Miaskowski C., Paul S.M., Cooper B., West C., Levine J.D., Elboim C., Hamolsky D., Abrams G., Luce J., Dhruva A., Langford D.J., Merriman J.D., Kober K., Baggott C., Leutwyler H. & Aouizerat B.E. (2014) Identification of patient subgroups and risk factors for persistent arm/shoulder pain following breast cancer surgery. *Eur J Oncol Nurs* 18, 242-253.
13. Dean L.T., DeMichele A., LeBlanc M., Stephens-Shields A., Li S.Q., Colameco C., Coursey M. & Mao J.J. (2015) Black breast cancer survivors experience greater upper extremity disability. *Breast Cancer Res Treat* 154, 117-125.

14. Shamley D., Lascurain-Aguirrebeña I., Oskrochi R. & Srinaganathan R. (2012) Shoulder morbidity after treatment for breast cancer is bilateral and greater after mastectomy. *Acta Oncol* 51, 1045-1053.
15. Harrington S., Padua D., Battaglini C., Michener L.A., Giuliani C., Myers J. & Groff D. (2011) Comparison of shoulder flexibility, strength, and function between breast cancer survivors and healthy participants. *J Cancer Surviv* 5, 167-174.
16. Greenlee H., Balneaves L.G., Carlson L.E., Cohen M., Deng G., Hershman D., Mumber M., Perlmutter J., Seely D., Sen A., Zick S.M. & Tripathy D.; Society for Integrative Oncology. (2014) Clinical practice guidelines on the use of integrative therapies as supportive care in patients treated for breast cancer. *J Natl Cancer Inst Monogr* 2014, 346-358.
17. De Groef A., Van Kampen M., Dieltjens E., Christiaens M.R., Neven P., Geraerts I. & Devoogdt N. (2015) Effectiveness of postoperative physical therapy for upper-limb impairments after breast cancer treatment: a systematic review. *Arch Phys Med Rehabil* 96, 1140-1153.
18. Lee M.S., Lee E.N. & Ernst E. (2011) Massage therapy for breast cancer patients: a systematic review. *Ann Oncol* 22, 1459-1461.
19. Pan Y.Q., Yang K.H., Wang Y.L., Zhang L.P. & Liang H.Q. (2014) Massage interventions and treatment-related side effects of breast cancer: a systematic review and meta-analysis. *Int J Clin Oncol* 19, 829-841.
20. Arroyo-Morales M., Olea N., Martínez M.M., Hidalgo-Lozano A., Ruiz-Rodríguez C. & Díaz-Rodríguez L. (2008) Psychophysiological effects of massage-myofascial release after exercise: a randomized sham-control study. *J Altern Complement Med* 14, 1223-1229.
21. Fernández-Pérez A.M., Peralta-Ramírez M.I., Pilat A., Moreno-Lorenzo C., Villaverde-Gutiérrez C. & Arroyo-Morales M. (2013) Can myofascial techniques modify immunological parameters? *J Altern Complement Med* 19, 24-28.
22. Fernández-Lao C., Cantarero-Villanueva I., Díaz-Rodríguez L., Cuesta-Vargas A.I., Fernández-Delas-Peñas C. & Arroyo-Morales M. (2012) Attitudes towards massage modify effects of manual therapy in breast cancer survivors: a randomised clinical trial with crossover design. *Eur J Cancer Care (Engl)* 21, 233-241.
23. Hanten W.P. & Chandler S.D. (1994) Effects of myofascial release leg pull and sagittal plane isometric contract-relax techniques on passive straight-leg raise angle. *J Orthop Sports Phys Ther* 20, 138-144.
24. Toro-Velasco C., Arroyo-Morales M., Fernández-de-Las-Peñas C., Cleland J.A. & Barreiro-Hernández F.J. (2009) Short-term effects of manual therapy on heart rate variability, mood state, and pressure pain sensitivity in patients with chronic tension-type headache: a pilot study. *J Manipulative Physiol Ther* 32, 527-535.
25. Manzini J.L. (2000) Declaración de Helsinki: Principios éticos para la investigación médica sobre sujetos humanos. *Acta bioeth* 6, 321-334.
26. Ley 14/2007, de 3 de julio, de Investigación Biomédica. Boletín Oficial del Estado, No. 159, BOE-A-2007-12945 (Jun 2, 2011).
27. Castro-Sánchez A.M., Matarán-Peñarrocha G.A., Granero-Molina J., Aguilera-Manrique G., Quesada-Rubio J.M. & Moreno-Lorenzo C. (2011) Benefits of massage-myofascial release therapy on pain, anxiety, quality of sleep, depression, and quality of life in patients with fibromyalgia. *Evid Based Complement Alternat Med* 2011, 561753.

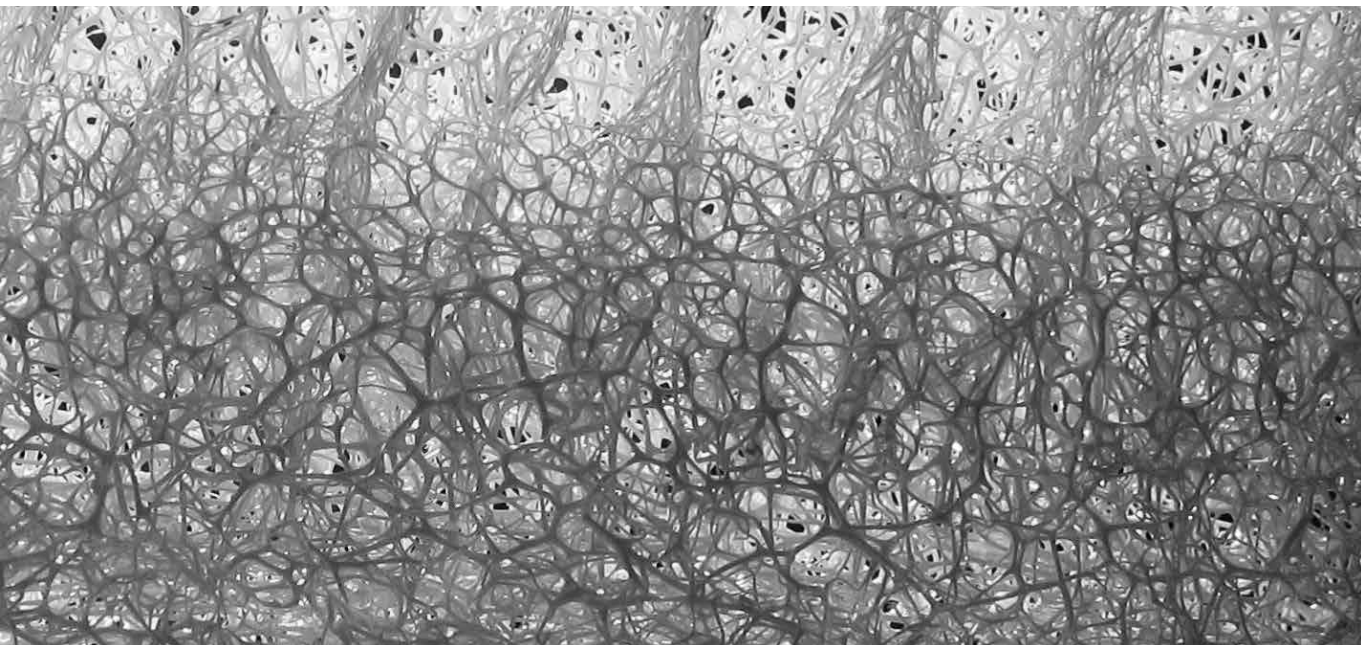
28. Arroyo-Morales M., Olea N., Martinez M., Moreno-Lorenzo C., Díaz-Rodríguez L. & Hidalgo-Lozano A. (2008) Effects of myofascial release after high-intensity exercise: a randomized clinical trial. *J Manipulative Physiol Ther* 31, 217-223.
29. Pilat A. (2003) *Myofascial therapies: myofascial induction*. McGraw-Hill Interamericana, Madrid.
30. Minasny B. (2009) Understanding the process of fascia unwinding. *Int J Ther Massage Bodywork* 2, 10-17.
31. Galiano-Castillo N., Ariza-García A., Cantarero-Villanueva I., Fernández-Lao C., Díaz-Rodríguez L., Legerén-Alvarez M., Sánchez-Salado C., Del-Moral-Avila R. & Arroyo-Morales M. (2013) Telehealth system (e-CUIDATE) to improve quality of life in breast cancer survivors: rationale and study protocol for a randomized clinical trial. *Trials* 14, 187.
32. Hansen M.V., Madsen M.T., Hageman I., Rasmussen L.S., Bokmand S., Rosenberg J. & Gögenur I. (2012) The effect of MELatOnin on Depression, anxiety, cognitive function and sleep disturbances in patients with breast cancer. The MELODY trial: protocol for a randomised, placebo-controlled, double-blinded trial. *BMJ Open* 2, e000647.
33. Carlsson A.M. (1983) Assessment of chronic pain. I. Aspects of the reliability and validity of the visual analogue scale. *Pain* 16, 87-101.
34. McCormack H.M., Horne D.J. & Sheather S. (1988) Clinical applications of visual analogue scales: a critical review. *Psychol Med* 18, 1007-1019.
35. Norkin C.C. & White J. (2006) *Goniometría: evaluación de la movilidad articular*. Marban, Barcelona.
36. Kolber M.J. & Hanney W.J. (2012) The reliability and concurrent validity of shoulder mobility measurements using a digital inclinometer and goniometer: a technical report. *Int J Sports Phys Ther* 7, 306-313.
37. Fernández-de-las-Peñas C., Alonso-Blanco C., Cuadrado M.L. & Pareja J.A. (2006) Forward head posture and neck mobility in chronic tension-type headache: a blinded, controlled study. *Cephalalgia* 26, 314-319.
38. Capuano-Pucci D., Rheault W., Aukai J., Bracke M., Day R. & Pastrick M. (1991) Intratester and intertester reliability of the cervical range of motion device. *Arch Phys Med Rehabil* 72, 338-340.
39. Peolsson A., Hedlund R., Ertzaard S. & Oberg B. (2000) Intra- and inter-tester reliability and range of motion of the neck. *Physiother Can* 52, 233-242.
40. McNair D.M., Lorr M. & Droppleman L.F. (1971) *Manual for the Profile of Mood States*. Educational and Industrial Testing Services, San Diego, CA.
41. Andrade E.M., Arce C. & Seoane G. (2002) Adaptación al español del cuestionario 'Perfil de los Estados de Ánimo' en una muestra de deportistas. *Psicothema* 14, 708-713.
42. Fernández-Lao C., Cantarero-Villanueva I., Díaz-Rodríguez L., Fernández-de-las-Peñas C., Sánchez-Salado C. & Arroyo-Morales M. (2012) The influence of patient attitude toward massage on pressure pain sensitivity and immune system after application of myofascial release in breast cancer survivors: a randomized, controlled crossover study. *J Manipulative Physiol Ther* 35, 94-100.
43. Moyer C.A. & Rounds J. (2009) The attitudes toward massage (ATOM) scale: reliability, valid-

- ity, and associated findings. *J Bodyw Mov Ther* 13, 22-33.
44. Todd K.H. & Funk J.P. (1996) The minimum clinically important difference in physician-assigned visual analog pain scores. *Acad Emerg Med* 3, 142-146.
 45. Warpenburg M.J. (2014) Deep Friction Massage in Treatment of Radiation-induced Fibrosis: Rehabilitative Care for Breast Cancer Survivors. *Integr Med (Encinitas)* 13, 32-36.
 46. Borstad J.D. & Szucs K.A. (2012) Three-dimensional scapula kinematics and shoulder function examined before and after surgical treatment for breast cancer. *Hum Mov Sci* 31, 408-418.
 47. Haddad C.A., Saad M., Perez M. del C. & Miranda Júnior F. (2013) Assessment of posture and joint movements of the upper limbs of patients after mastectomy and lymphadenectomy. *Einstein (Sao Paulo)* 11, 426-434.
 48. Johansen S., Fosså K., Nesvold I.L., Malinen E. & Fosså S.D. (2014) Arm and shoulder morbidity following surgery and radiotherapy for breast cancer. *Acta Oncol* 53, 521-529.
 49. Stubblefield M.D. & Keole N. (2014) Upper body pain and functional disorders in patients with breast cancer. *PM R* 6, 170-183.
 50. Moyer C.A., Rounds J. & Hannum J.W. (2004) A meta-analysis of massage therapy research. *Psychol Bull* 130, 3-18.
 51. Ward R.C. (2002) Integrated neuromusculoskeletal release and myofascial release. In: *Foundations for Osteopathic Medicine 2nd edition* (ed Ward R.C.). Lippincott Williams and Wilkins, Philadelphia, PA.
 52. Dorko B.L. (2003) The analgesia of movement: ideomotor activity and manual care. *Int J Osteopath Med* 6, 93-95.
 53. Schleip R. (2003) Fascial plasticity: a new neurobiological explanation. Part 1. *J Bodyw Mov Ther* 7, 11-19.
 54. Pilat A. (2016) Myofascial induction approaches. In: *Manual Therapy for Musculoskeletal Pain Syndromes: An Evidence- and Clinical-Informed Approach*. 1st ed (ed Fernández-de-las-Peñas C., Cleland J.A., Dommerholt J.). Churchill Livingstone, China.
 55. Caro-Morán E., Fernández-Lao C., Díaz-Rodríguez L., Cantarero-Villanueva I., Madeleine P. & Arroyo-Morales M. (2016) Pressure Pain Sensitivity Maps of the Neck-Shoulder Region in Breast Cancer Survivors. *Pain Med*, "In press".

ESTUDIO II
EFFECTS OF A SINGLE
MYOFASCIAL INDUCTION SESSION
ON NEURAL MECHANOSENSITIVITY
IN BREAST CANCER SURVIVORS:
A SECONDARY ANALYSIS
OF A CROSSOVER STUDY

Journal of Manipulative and Physiological Therapeutics (2020)

Castro-Martín, E., Galiano-Castillo, N., Ortiz-Comino, L., Cantarero-Villanueva, I., Lozano-Lozano, M., Arroyo-Morales, M., & Fernández-Lao, C. (2020). Effects of a Single Myofascial Induction Session on Neural Mechanosensitivity in Breast Cancer Survivors: A Secondary Analysis of a Crossover Study. *Journal of manipulative and physiological therapeutics*, 43(4), 394–404. <https://doi.org/10.1016/j.jmpt.2019.03.016>





ABSTRACT

Objectives

The purpose of this study was to investigate the short-term effects of myofascial induction on mechanosensitivity of upper limb nerves.

Methods

In this secondary analysis of a randomized, single-blind, placebo-controlled crossover study, 21 breast cancer survivors with stage I-IIIa cancer were randomly allocated to an experimental group (30 minutes of myofascial induction session) or placebo control group (unplugged pulsed 30 minutes of shortwave therapy), with a 4-week washout period between sessions that occurred in a physical therapy laboratory in the Health Science Faculty (University of Granada, Spain). Range of motion (universal goniometry), structural differentiation, symptoms (yes/no), and pressure pain thresholds (electronic algometry) were assessed during neurodynamic tests and attitude toward massage scale as covariate.

Results

An analysis of covariance revealed significant time $\times$ group interactions for range of motion in affected upper limb nerves (median, $P < .001$; radial, $P = .036$; ulnar, $P = .002$), but not for non-affected upper limb nerves (median, $P = .083$; radial, $P = .072$; ulnar, $P = .796$). A χ^2 or Fisher exact test, as appropriate, also revealed a significant difference ($P = .044$) in sensitivity for the affected upper limb ulnar nerve in the experimental group, whereas the rest of the assessed nerves (affected and nonaffected upper limb nerves) showed no significant changes in either the experimental or control groups ($P > .05$). An analysis of covariance revealed no significant

interactions on pressure pain thresholds over the nerves for affected (all $P > .05$) and nonaffected (all $P > .05$) upper limb nerves.

Conclusion

A single myofascial induction session may partially improve mechanosensitivity of median, radial, and ulnar nerves and yield positive effects on symptom mechanosensitivity, especially regarding the ulnar nerve in breast cancer survivors.

INTRODUCTION

A recent study composed of three large cohorts reported that moderate to severe persistent pain occurred in 13.5% to 20.3% of patients at 9 to 12 months after breast cancer (BC) surgery.¹ In addition, preoperative pain in the surgical area, high body mass index, axillary lymph node dissection, and more severe acute postoperative pain intensity at the seventh postoperative day were described as potential predictors of this troublesome adverse effect.¹

Currently, postmastectomy pain syndrome is widely accepted to refer to this painful condition,^{2,3} which consists of any pain persisting beyond the normal period of healing after medical treatment, with a neuropathic origin in the majority of cases.^{4,5} Moreover, this syndrome can be aggravated by adjuvant treatment,⁶ such as chemotherapy or radiotherapy. Velasco et al⁷ reinforce the idea of neurotoxic damage 1 month after finishing chemotherapy, emphasizing nerve growth factor as a biomarker of nerve damage, whereas radiotherapy causes both direct (axonal damage and demyelination) and indirect (compression by fibrosis) injuries in peripheral nerves even years after treatment.^{8,9}

These disabling injuries can increase pain intensity and compromise patient recovery; therefore, it is imperative that health professionals seek appropriate treatment in these cases.

The physiopathology of this syndrome has received increased attention in the last decade with different perspectives involved in possible explicative models. Among these models, pre-inflammatory and neuropathic pain processes, as a result of surgical injury to different neural structures, might be implied in sensitivity of the neck–arm area^{10,11} and may be responsible for peripheral and central sensitization in breast cancer survivors (BCSs).^{12, 13, 14} In contrast, Juhl et al¹⁵ states that patients report persistent pain that is often of nociceptive nature, rather than neuropathic pain. Thus, it seems obvious to think of the need for different strategies for optimal pain control.

Manual therapies have shown effectiveness in a wide variety of health problems.¹⁶ Myofascial induction (MI) is characterized as a massage therapy modality, with remodeling traits, always avoiding arbitrary stimulus application (altered force intensity and direction) and focusing on the intrinsic natural tissue response.¹⁷ This specific manual modality has also shown the ability to improve different BC conditions, such as pain,^{18,19} joint movement,¹⁹ fatigue,²⁰ heart variability, mood,²¹ and even parasympathetic and immune function,²² which further exhibits its achievements in evidence, safety, and effectiveness.²³ However, none of these studies have specifically assessed the short-term influence of MI on a pain component, such as the neural mechanosensitivity derived from oncologic treatment; hence, an important knowledge gap exists in the mechanical effects of this intervention in neural structures.

In general, massage, as a form of complementary therapy, has been selected for patients to treat their pain symptoms because conventional treatments do not always yield the expected results.^{24,25} The therapist's profile, type of maneuvers, and patient characteristics are the main components in the equation that determines the effectiveness of manual therapies. Although substantial effort has been made to clarify the mechanisms of action of massage therapy in terms of blood pressure, hypothalamus-pituitary-adrenocortical axis,²⁶ or immune function,²⁷ current research should now focus all efforts on the characteristics of patients as responders, clarifying why some patients respond to massage and others not. The literature has already given some preliminary information about how the response to stress²⁸ or attitude toward massage^{21,22} could influence.

In this context, Fernández-Lao et al^{21,22} found that BCSs with a positive attitude toward massage influenced on immunoglobulin A concentration²² and fatigue,²¹ such that both conditions were modulated by this positive attitude. However, there are no previous studies that have analyzed the influence of this attitude toward MI over neural mechanosensitivity.

Therefore, the main aim of this randomized, single-blind, placebo-controlled crossover design was to investigate short-term effects of a single MI session on range of motion (ROM), symptom reproduction, and pressure pain thresholds (PPTs), all measured through Upper Limb Neurodynamic Tests (ULNTs), besides determining the possible influence or not of patient's attitudes toward massage (ATOM) on outcome measures in BCSs. We hypothesized that a single MI session would improve more neural mechanosensitivity than sham pulsed shortwave therapy in BCSs.

METHODS

Design

This study is a secondary analysis of data from a previous crossover design (ClinicalTrials.gov NCTX).¹⁹ The original study was approved by the ethics committee of the University of Granada (FIS PI10/02749-02764) and was performed according to the guidelines established by the Declaration of Helsinki for biomedical research (14/2007).²⁹ The study design and methods have been described in detail in a previous publication¹⁹ and are summarized here. A randomized, single-blind, placebo-controlled crossover design occurred in a physical therapy laboratory in the Health Science Faculty (University of Granada, Spain). The objective of the main study mentioned above was to investigate the immediate effects of MI on perceived pain, cervical or shoulder ROM, and mood state in BCSs with shoulder or arm morbidity. Therefore, those variables are not included in the present analysis.

Participants

Twenty-one BCSs from the Oncology and Breast units at the Virgen de las Nieves Hospital (Granada, Spain) were recruited for the current study. To be eligible, patients had to meet the following inclusion criteria: (1) BC stage I-IIIa; (2) age between 25 and 65 years; and (3) completed adjuvant therapy, except hormonal treatment. Patients were excluded if they (1) had cancer recurrence; (2) had trauma or surgery in the cervical, thoracic, or upper limb areas not related to cancer in the last 6 months; or (3) had not been given medical clearance for participation. All participants read and signed an informed consent form before their inclusion.

Sample Size

The power calculation was done for the main analysis¹⁹ and was based on the visual analogue scale, providing an 80% power to detect a mean difference of 1.5 points with an SD of 3 points, a type 1 error (α) of 7.5%, and a type 2 error (β) of 20%. This power calculation resulted in 20 patients in total and therefore 20 patients for each study group (MI or placebo). To accommodate expected dropouts before study completion, a total of 21 participants were recruited. The same calculation was applied to this sub-study. This study finished once the desired sample size was reached.

Interventions

The procedure followed in both arms of the study has already been described in detail in a previous publication,¹⁹ and it is summarized here. We conducted 2 sessions (MI or placebo) separated by a 4-week washout period, at the same time of the day, between 10:00 AM and 1:00 PM to avoid circadian rhythm-induced variations on the physiologic effects of MI.³⁰ During the experimental session, each patient received an MI intervention focused on the affected upper limb area for 30 minutes (adapted to the patient's tissue response) using the Pilat approach.^{31,32} Myofascial unwinding (Video 1) is a safe, efficient, and highly effective technique for restoring tissue mobility and function.³³ The physiotherapist applied a gentle and sustained traction of the upper limb (as if eliminating the force of gravity), and accompanied the different movements that arise; the patient must give up control and relax,³¹ and in this way, applying the stimulus and following the spontaneous response of the limb for 30 minutes. Myofascial unwinding is understood as a neu-

robiological process that uses the theory of the dynamic system of self-regulation,³² whereas the control session consisted of the application of 30 minutes of unplugged pulsed shortwave therapy. This modality of study group with a device without any electrical current applied has already been used in previous studies as placebo group.^{30,34}

Neural Mechanosensitivity Outcome Measures

To assess the neural tolerance to movement, we used a neurodynamic test, specifically ULNTs for the median (ULNT1_{MEDIAN}), radial (ULNT_{RADIAL}), and ulnar nerves (ULNT_{ULNAR}) following the process described by Butler.³⁵

All patients were positioned in supine position with legs uncrossed. The head was placed without a pillow and at neutral rotation. The untested arm rested by their side. Next, patients were instructed to communicate the onset of any sensation, such as pain or stretch in the areas of the arm or the neck. All the ULNTs were performed bilaterally and always first on the nonaffected side; therefore, the sensation was used as a reference for the affected side. Each ULNT was developed with a standardized sequence³⁶ until the end of the movement range or until the symptoms experienced by the patients were reproduced. Pain and other symptoms that occurred during the test were respected. The test was continued with the elbow extension or the shoulder abduction to the normal end of range if patients did not experience any pain (Fig. 1-3).



Fig 1. Upper limb median nerve neurodynamic test.



Fig 2. Upper limb radial nerve neurodynamic test.



Fig 3. Upper limb ulnar nerve neurodynamic test.

Related to the development of this test we performed 3 assessments:

1. Shoulder ROM for radial-ulnar and elbow ROM for median nerves. This assessment was developed at the end of test performance, and we used a standard goniometer, based on a previously reported procedure.³⁷ Tests were stopped when patients identified, at least partially, their symptoms, shoulder girdle attempted to change the position to avoid tension or pain, or the examiner found muscular resistance to movement. A similar methodology has been previously described in studies of brachial plexus provocation tests.¹²
2. Structural differentiation and symptom reproduction. This assessment was developed when the symptomatology was reproduced by placing a sensitizing movement and then another that desensitized the nerve to consider the test as positive. Finally, we recorded if the ULNTs elicited previous patient sensation. This analysis of symptom reproduction is a challenge still to be explored in previous BCS studies.
3. The PPT is traditionally defined as the minimal amount of pressure, where a sensation of pressure first changes to pain.³⁸ We used an electronic algometer (FDIX; Wagner Instruments, Greenwich, CT), applying the pressure at an approximate rate of 0.5 kg/s by a 1-cm² probe. We developed a previously published methodology widely reported in the same population.^{11,13} The PPTs were assessed bilaterally, over peripheral nerve trunks of the median, radial, and ulnar nerves.^{12,39}

Patient Attitude as an Outcome Measure

The ATOM scale is a questionnaire composed of 9 items, which measures overall attitude toward massage. The ATOM scale contains 2 subscales —namely, “Massage as healthful” and “Massage as pleasant”—with five ordered category response options ranging from “strongly disagree” to “strongly agree.” Both subscales have shown an adequate reliability in previous studies ($\alpha = 0.70\text{--}0.80$).⁴⁰

Statistical Analysis

Descriptive patient statistics are expressed as the mean (SD) and frequency (percentage). The Kolmogorov-Smirnov test showed normal distribution of the data ($P > .05$). A t test, χ^2 test, or Fisher exact test, as appropriate, was used to analyze the between-group differences at baseline. To examine the effect of both interventions considering quantitative variables, a 2-way repeated-measures analysis of covariance (ANCOVA) with intervention (experimental-placebo) as the between-group variable, time (pre-post) as the within-group variable, and ATOM subscales as covariates were used. Categorical variables as structural differentiation and symptom reproduction were analyzed without ATOM covariates because of the nature of the statistical test (χ^2 test or Fisher exact test, as appropriate). The main hypothesis of interest was time $\times$ group interaction for quantitative variables. Consistent with our published study,¹⁹ if a significant interaction was identified, pairwise comparisons were performed to determine whether between-group differences in change scores were significant. We corrected all the analyses for pairwise comparisons (multiplying P value obtained in each contrast of mean by 4). We used the IBM SPSS Statistics 21 (IBM Corporation, Armonk, NY) for the analysis, and $P < .05$ was considered significant.

RESULTS

A total of 20 BSCs with a mean age 51.15 ± 8.68 years, the majority (75%) of which were BC stage II and all of which (100%) had received radiotherapy and chemotherapy, participated in this study (Table 1). No outcome measures

were measured in one participant because of no tolerance during ULNTs. None of the patients had received rehabilitation treatment before this study. At the beginning of the study, there were no group differences in study variables (continuous and categorical variables; $P > .05$).

Table 1. Sociodemographic and clinical characteristics.

Variable	BSC (N = 20)
Age (years), mean (SD)	51.15 (8.68)
Time since surgery, n (%)	
≤12 months	13 (65)
>12 months	7 (35)
Cancer stage, n (%)	
I	3 (15)
II	15 (75)
IIIA	2 (10)
Type of surgery, n (%)	
Lumpectomy	2 (10)
Quadrantectomy	5 (25)
Unilateral mastectomy	11 (55)
Mastectomy & lymphadenectomy	2 (10)
Medical treatment, n (%)	
Radiotherapy	0
Chemotherapy	0
Radiotherapy & chemotherapy	20 (100)
Menopause, n (%)	
Pre-menopause	4 (20)
Post-menopause	16 (80)

Effects of MI on Shoulder and Elbow ROM in ULNTs

The ANCOVA revealed a significant time $\times$ group interaction for affected upper limb nerves (median: $F = 29.001$, $P < .001$; radial: $F = 4.723$, $P = .036$; ulnar: $F = 11.453$, $P = .002$), but not

for nonaffected upper limb nerves (median: $F = 3.160$, $P = .083$; radial: $F = 3.430$, $P = .072$; ulnar: $F = 0.068$, $P = .796$; Table 2). Pairwise comparisons revealed that the BSCs in the experimental group significantly improved (all $P < .004$) on goniometry for affected upper limb nerves after the MI intervention, whereas similar results

($P > .05$) were obtained after placebo control. Only for affected upper limb ulnar nerve did the placebo group also significantly increase ROM ($P = .044$); however, in this case, these participants did not achieve reaching the minimum

clinical difference, which is 18° (experimental group, 22.65 ± 19.05 vs placebo control 6.35 ± 10.04).⁴¹ The ATOM scores did not influence the results. The variability of scores (change scores) for each of the groups has been shown in Table 2.

Table 2. Pre-intervention, post-intervention and change scores on ROM in ULNTs (N=20).

ROM	MI session	Placebo session
Affected Upper Limb Median nerve (deg)		
Pre-intervention	99.55±23.73 (95% CI 88.44; 110.65)	97.15±21.10 (95% CI 87.27; 107.03)
Post-intervention	120.95±26.68 (95% CI 108.46; 133.43)	92.20±25.30 (95% CI 80.36; 104.04)
Pre-post differences	21.40±15.20 (95% CI 14.28; 28.52) ^a	-4.95±15.74 (95% CI -12.31; 2.41)
Non-affected Upper Limb Median nerve (deg)		
Pre-intervention	122.75±30.47 (95% CI 108.49; 137.01)	113.95±19.11 (95% CI 105.00; 122.89)
Post-intervention	127.60±25.23 (95% CI 115.79; 139.41)	111.35±22.15 (95% CI 100.98; 121.72)
Pre-post differences	4.85±14.96 (95% CI -2.15; 11.85)	-2.60±11.29 (95% CI -7.88; 2.68)
Affected Upper Limb Radial nerve (deg)		
Pre-intervention	49.65±17.83 (95% CI 41.31; 57.99)	45.00±14.38 (95% CI 38.27; 51.73)
Post-intervention	66.85±17.51 (95% CI 58.65; 75.05)	52.75±17.51 (95% CI 44.56; 60.94)
Pre-post differences	17.20±13.83 (95% CI 10.73; 23.67) ^b	7.75±13.67 (95% CI 1.35; 14.15)
Non-affected Upper Limb Radial nerve (deg)		
Pre-intervention	65.25±17.88 (95% CI 56.88; 73.62)	69.00±23.82 (95% CI 57.85; 80.15)
Post-intervention	68.00±18.91 (95% CI 59.15; 76.85)	64.40±21.50 (95% CI 54.33; 74.46)
Pre-post differences	2.75±5.54 (95% CI 0.15; 5.34)	-4.60±16.86 (95% CI -12.49; 3.29)
Affected Upper Limb Ulnar nerve (deg)		
Pre-intervention	65.00±20.61 (95% CI 55.35; 74.64)	59.35±18.69 (95% CI 50.60; 68.10)
Post-intervention	87.65±25.27 (95% CI 75.82; 99.48)	65.70±17.15 (95% CI 57.67; 73.73)
Pre-post differences	22.65±19.05 (95% CI 13.73; 31.57) ^b	6.35±10.04 (95% CI 1.65; 11.05)
Non-affected Upper Limb Ulnar nerve (deg)		
Pre-intervention	91.20±26.79 (95% CI 78.66; 103.74)	85.60±23.68 (95% CI 74.52; 96.68)
Post-intervention	95.35±20.93 (95% CI 85.56; 105.14)	88.70±26.37 (95% CI 76.36; 101.04)
Pre-post differences	4.15±10.48 (95% CI -0.76; 9.06)	3.10±14.72 (95% CI -3.79; 9.99)

Data are shown as mean±SD (95% confidence interval for the mean) at pre-intervention and post-intervention and as mean differences±SD (95% confidence interval for the difference) for pre-post differences. Significant time x group interaction (ANCOVA test, ^a $P < .001$ ^b $P < .05$). ROM: range of motion; ULNTs: upper limb neurodynamic tests; MI: myofascial induction; CI: confidence interval.

Effects of MI on Structural Differentiation and Symptom Reproduction in ULNTs

The χ^2 or Fisher exact test, as appropriate, only found a significant difference ($P = .044$) in sensitivity for the affected upper limb ulnar nerve in the experimental group, where a total of 6 patients improved their level of sensitivity from before to after intervention, and therefore will not reproduce their symptoms. The rest

of the assessed nerves showed no significant changes either in the experimental or control groups: median nerve (affected upper limb [EG, $P = 1.000$; CG, $P = .695$] and no-affected upper limb [EG, $P = 1.000$; CG, $P = 1.000$]), radial nerve (affected upper limb [EG, $P = .407$; CG, $P = 1.000$] and nonaffected upper limb [EG, $P = 1.000$; CG, $P = .749$]), ulnar nerve (affected upper limb [CG, $P = .605$]), and nonaffected upper limb (EG, $P = .749$; CG, $P = 1.000$; Table 3).

Table 3. Pre-intervention, post-intervention and change scores on structural differentiation and symptom reproduction in ULNTs ($N=20$).

	MI session		Placebo session	
	Yes <i>n</i> (%)	No <i>n</i> (%)	Yes <i>n</i> (%)	No <i>n</i> (%)
Affected Upper Limb Median nerve				
Pre-intervention	17 (85)	3 (15)	15 (75)	5 (25)
Post-intervention	16 (80)	4 (20)	17 (85)	3 (15)
Pre-post differences	-1	1	2	-2
Non-affected Upper Limb Median nerve				
Pre-intervention	10 (50)	10 (50)	12 (60)	8 (40)
Post-intervention	10 (50)	10 (50)	12 (60)	8 (40)
Pre-post differences	0	0	0	0
Affected Upper Limb Radial nerve				
Pre-intervention	18 (90)	2 (10)	16 (80)	4 (20)
Post-intervention	15 (75)	5 (25)	16 (80)	4 (20)
Pre-post differences	-3	3	0	0
Non-affected Upper Limb Radial nerve				
Pre-intervention	10 (50)	10 (50)	11 (55)	9 (45)
Post-intervention	10 (50)	10 (50)	12 (60)	8 (40)
Pre-post differences	0	0	1	-1
Affected Upper Limb Ulnar nerve				
Pre-intervention	19 (95)	1 (5)	17 (85)	3 (15)
Post-intervention	13 (65)	7 (35)	19 (95)	1 (5)
Pre-post differences	-6 ^a	6 ^a	2	-2
Non-affected Upper Limb Ulnar nerve				
Pre-intervention	9 (45)	11 (55)	8 (40)	12 (60)
Post-intervention	8 (40)	12 (60)	8 (40)	12 (60)
Pre-post differences	-1	1	0	0

Data are shown as frequencies (percentages) at pre-intervention and post-intervention and as frequency differences for pre-post differences. Significant Chi square test/Fisher's exact test, as appropriate ^a $P < .05$. ULNTs: upper limb neurodynamic tests; MI: myofascial induction.

Effects of MI on PPT Over the Nerves in ULNTs

The ANCOVA found no significant time $\times$ group interactions for affected upper limb nerves (median: $F = 0.320$, $P = .575$; radial: $F = 0.010$, $P = .921$; ulnar: $F = 1.016$, $P = .320$) or for non-

affected upper limb nerves (median: $F = 0.104$, $P = .749$; radial: $F = 0.199$, $P = .658$; ulnar: $F = 0.208$, $P = .651$; Table 4). The ATOM scores did not influence the results. The variability of scores (change scores) for each of the groups has been shown in Table 4.

Table 4. Pre-intervention, post-intervention and change scores on PPT over the nerves in ULNTs ($N=20$).

PPT nerves	MI session	Placebo session
Affected Upper Limb Median nerve (kg/s)		
Pre-intervention	212.46 $\pm$ 104.16 (95% CI 163.71; 261.21)	185.09 $\pm$ 76.09 (95% CI 149.47; 220.70)
Post-intervention	214.14 $\pm$ 82.60 (95% CI 175.48; 252.80)	174.81 $\pm$ 65.17 (95% CI 144.31; 205.30)
Pre-post differences	1.68 $\pm$ 71.31 (95% CI -31.69; 35.05)	-10.28 $\pm$ 62.08 (95% CI -39.33; 18.77)
Non-affected Upper Limb Median nerve (kg/s)		
Pre-intervention	253.28 $\pm$ 82.72 (95% CI 214.56; 291.99)	219.31 $\pm$ 72.76 (95% CI 185.25; 253.36)
Post-intervention	258.82 $\pm$ 112.19 (95% CI 206.32; 311.33)	215.53 $\pm$ 55.93 (95% CI 189.35; 241.71)
Pre-post differences	5.54 $\pm$ 109.14 (95% CI -45.53; 56.62)	-3.78 $\pm$ 69.04 (95% CI -36.09; 28.54)
Affected Upper Limb Radial nerve (kg/s)		
Pre-intervention	254.54 $\pm$ 102.30 (95% CI 206.66; 302.42)	228.29 $\pm$ 79.79 (95% CI 190.94; 265.63)
Post-intervention	271.68 $\pm$ 114.38 (95% CI 218.15; 325.21)	243.38 $\pm$ 83.11 (95% CI 204.48; 282.28)
Pre-post differences	17.14 $\pm$ 63.29 (95% CI -12.48; 46.76)	15.10 $\pm$ 65.63 (95% CI -15.62; 45.81)
Non-affected Upper Limb Radial nerve (kg/s)		
Pre-intervention	295.50 $\pm$ 93.42 (95% CI 251.78; 339.23)	248.49 $\pm$ 98.27 (95% CI 202.50; 294.48)
Post-intervention	295.06 $\pm$ 83.82 (95% CI 255.83; 334.29)	258.96 $\pm$ 95.32 (95% CI 214.35; 303.57)
Pre-post differences	-0.44 $\pm$ 65.25 (95% CI -30.98; 30.09)	10.47 $\pm$ 87.84 (95% CI -30.64; 51.58)
Affected Upper Limb Ulnar nerve (kg/s)		
Pre-intervention	372.02 $\pm$ 146.91 (95% CI 303.26; 440.77)	328.21 $\pm$ 143.24 (95% CI 261.17; 395.25)
Post-intervention	386.34 $\pm$ 158.53 (95% CI 312.14; 460.53)	310.34 $\pm$ 124.48 (95% CI 252.08; 368.60)
Pre-post differences	14.32 $\pm$ 104.09 (95% CI -34.40; 63.03)	-17.87 $\pm$ 97.74 (95% CI -63.62; 27.87)
Non-affected Upper Limb Ulnar nerve (kg/s)		
Pre-intervention	439.83 $\pm$ 179.35 (95% CI 355.90; 523.77)	374.46 $\pm$ 99.97 (95% CI 327.67; 421.25)
Post-intervention	434.21 $\pm$ 166.53 (95% CI 356.27; 512.14)	354.73 $\pm$ 124.13 (95% CI 296.64; 412.83)
Pre-post differences	-5.63 $\pm$ 116.52 (95% CI -60.16; 48.90)	-19.73 $\pm$ 74.48 (95% CI -54.59; 15.12)

Data are shown as mean $\pm$ SD (95% confidence interval for the mean) at pre-intervention and post-intervention and as mean differences $\pm$ SD (95% confidence interval for the difference) for pre-post differences. PPT: pressure pain threshold; ULNTs: upper limb neurodynamic tests; MI: myofascial induction; CI: confidence interval.

DISCUSSION

We found an increasing ROM during ULNTs of the median, radial, and ulnar nerves. The MI also demonstrated positive effects in symptom reproduction in ULNT_{ULNAR} in the affected side when compared with the placebo session. We did not find significant positive effects of the session in pressure pain sensitivity in neural tissue. All these results were not influenced by patients' attitudes toward MI.

Previous research has shown the short-term effectiveness of MI in cancer-related pain and other symptoms, such as shoulder dysfunctions and mood impairments.^{19, 20, 21} In fact, a recent systematic review proposes MI, and other stretching and mobilization techniques, to treat the pain and shoulder joint impairments after BC treatment.⁴² However, until the present, we did not know with certainty the influence of these techniques on the neural mechanosensitivity.

Our results reveal an improvement in the tolerance to movement, through an increased ROM, during the ULNTs of the three nerves, as one component of neural mechanosensitivity after an MI session on the affected upper limb. Antolino-Campillos et al⁴³ had similar effects using an MI technique in subjects with cervical whiplash. The MI maneuver proposed in the present work is not directly focused on the treatment of the neural tissue, but it follows the theory of tensegrity,^{44, 45, 46} which defends a structural concept of the body, and fascial tension in

some points of the body may involve the whole structure,⁴⁷ such that a possible explanation of the results of myofascial techniques could be related to that connection. Future research should study this fact in more depth.

Several explanations could justify the results of the present study. On the one hand, it is known that BCSs present scar tissue with adherences to the underlying tissues,¹⁵ which involves the neural tissue.¹³ MI produces external mechanical forces that could be beneficial for reducing fibrosis and pain. The unwinding technique used in this study is considered as deep-level technique, which has a deeper effect and causes changes at a distance.³¹ The second explanation could be related to the fact that the innervation of the neural bed and the *nervi nervorum* of the neuroconnective tissue (with sympathetic fibers, unmyelinated type C, and encapsulated mechanoreceptors)^{48,49} could respond to the gentle impulse maintained by the MI through the skin and favoring a deeper modulation of mechanosensitivity by means of medullary blockade of nociceptive sensations and the activation of inhibitory descending pain systems.^{50,51} As with any manual therapy, the effects of MI would be associated with biomechanical changes with neurophysiological responses.^{52, 53, 54} Finally, the relaxing effect of MI⁵⁵ might facilitate the reduction of the anxiety state,⁵⁶ improving patient sensitivity.

We did not find differences between the two approaches in BCSs on neural sensitization assessed by PPTs. These results are in line with previous works presented by Fernández-Lao et al²² where the short-term effects of MI were evaluated in BSCs and did not find improvements. Heredia-Rizo et al⁵⁷ assessed changes in PPTs in healthy subjects after myofascial techniques and did not find any effect. It is possible that a single session of MI was not enough to activate clearly the descendent inhibitory system. However, the results show an improvement on the patient perception of symptoms from the ulnar nerve after the MI session. We hypothesized that the unwinding technique, based on a

soft-traction mechanism, had important effects over the mechanic component of the nerves and maybe had a positive effect over the symptoms' reproduction after the session, but not over the nociceptive pain (PPTs). In addition, we think that pressure algometry produces more mechanical load on the nerve trunks than the tension that produces the joint mobilization performed during the ULNT³⁵; therefore the sensation experienced by the patient is more painful during the PPT assessment.

Finally, we did not find any influence of patient attitude on the results presented. This finding is not in line with previous works published,^{21,22} where patients with a positive attitude over manual techniques obtained better results. The protocol proposed by Fernández-Lao was based on more different myofascial techniques, and our treatment was based on only a single unwinding maneuver. However, our results were in line with a previous work,¹⁹ where the attitudes did not influence the results. Maybe the mechanical and more local effect of the unwinding maneuver are not modulated by the patient's perspective. It is possible that the patient's attitude has an influence over more complex processes modulated through psychoneuroimmunology stimuli. We believe this finding implies more patients would get benefits from the MI treatments, independently, based on their attitudes toward the treatment. Hence, the protocol proposed would be effective on structural neural injuries without the influence of previous patient experience.

Some limitations must be stated for the present study. Additional studies with longer treatments and longer follow-up periods need to be conducted to elucidate the effectiveness of the technique in BCSs. In addition, the same therapist performed all manual therapy interventions, and this might limit the generalization of

the results. It is possible that different, more sophisticated assessment measures would lead to different or more specific results. However, to our knowledge, this is the first study assessing the effects of MI over neural mechanosensitivity in BSCs. Finally, the reduced but adequate sample size used in this study could reduce the interindividual differences of the participants; therefore, future works should use a different methodological design to assess the long-term effects of the MI on BSCs.

CONCLUSION

A single MI maneuver might improve tolerance to movement for median, radial, and ulnar nerves and obtain positive effects in the patient's symptom reproduction at the level of the ulnar nerve in BSCs, reducing the neural mechanosensitivity and improving the patient's sensation during upper limb movements. A single session of MI seems to be insufficient to show effects in all the components of the neural mechanosensitivity.

Funding Sources and Potential Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): M.A.M., E.C.M.

Design (planned the methods to generate the results): M.A.M., N.G.C., E.C.M.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): M.A.M., N.G.C.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): E.C.M., L.O.C., M.L.L.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.F.L., I.C.V. (analysis) and E.C.M., N.G.C., L.O.C., I.C.V., M.L.L., M.A.M., C.F.L. (interpretation).

Literature search (performed the literature search): E.C.M., N.G.C., L.O.C., I.C.V., M.L.L., M.A.M., C.F.L.

Writing (responsible for writing a substantive part of the manuscript): E.C.M., N.G.C., C.F.L.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): E.C.M., N.G.C., L.O.C., I.C.V., M.L.L., M.A.M., C.F.L.

Other (list other specific novel contributions)

Drafting manuscript: N.G.C.

Final approval and agreement: E.C.M., N.G.C., L.O.C., I.C.V., M.L.L., M.A.M., C.F.L.

PRACTICAL APPLICATIONS

- Myofascial induction improves partially mechanosensitivity of affected upper limb nerves.
- Patient experience does not influence on effectiveness of myofascial induction.
- Manual therapy is an encouraging treatment option for postmastectomy pain syndrome.

REFERENCES

1. TJ Meretoja, KG Andersen, J Bruce, et al. Clinical prediction model and tool for assessing risk of persistent pain after breast cancer surgery *J Clin Oncol*, 35 (15) (2017), pp. 1660-1667
2. MD. Stubblefield The underutilization of rehabilitation to treat physical impairments in breast cancer survivors *PM R*, 9 (9S2) (2017), pp. S317-S323
3. MD Stubblefield, N. Keole Upper body pain and functional disorders in patients with breast cancer *PM R*, 6 (2) (2014), pp. 170-183
4. L Macdonald, J Bruce, NW Scott, WCS Smith, WA Chambers Long-term follow-up of breast cancer survivors with post-mastectomy pain syndrome *Br J Cancer*, 92 (2) (2005), pp. 225-230
5. M Torres Lacomba, O Mayoral del Moral, JL Coperias Zazo, RD Gerwin, AZ Goñi Incidence of myofascial pain syndrome in breast cancer surgery: a prospective study *Clin J Pain*, 26 (4) (2010), pp. 320-325
6. JM de Miguel-Jimeno, I Forner-Cordero, M Zabalza-Azparren, B Matute-Tobias [Postmastectomy pain syndrome in our region: characteristics, treatment, and experience with gabapentin] *Rev Neurol*, 62 (6) (2016), pp. 258-266
7. R Velasco, X Navarro, M Gil-Gil, M Herrando-Grabulosa, A Calls, J Bruna Neuropathic pain and nerve growth factor in chemotherapy-induced peripheral neuropathy: prospective clinical-pathological study *J Pain Symptom Manage*, 54 (6) (2017), pp. 815-825
8. S Delanian, J-L Lefaix, P-F Pradat Radiation-induced neuropathy in cancer survivors *Radiother Oncol*, 105 (3) (2012), pp. 273-282

9. P-F Pradat, S Delanian Late radiation injury to peripheral nerves *Handb Clin Neurol*, 115 (2013), pp. 743-758
10. C Fernández-Lao, I Cantarero-Villanueva, C Fernández-de-Las-Peñas, R Del-Moral-Ávila, L Arendt-Nielsen, M Arroyo-Morales Myofascial trigger points in neck and shoulder muscles and widespread pressure pain hypersensitivity in patients with postmastectomy pain: evidence of peripheral and central sensitization *Clin J Pain*, 26 (9) (2010), pp. 798-806
11. C Fernández-Lao, I Cantarero-Villanueva, C Fernández-de-las-Peñas, R Del-Moral-Ávila, S Menjón-Beltrán, M Arroyo-Morales Widespread mechanical pain hypersensitivity as a sign of central sensitization after breast cancer surgery: comparison between mastectomy and lumpectomy *Pain Med*, 12 (1) (2011), pp. 72-78
12. E Caro-Morán, L Díaz-Rodríguez, I Cantarero-Villanueva, N Galiano-Castillo, M Arroyo-Morales, C Fernández-Lao Nerve pressure pain hypersensitivity and upper limb mechanosensitivity in breast cancer survivors: a case-control study *Pain Med (United States)*, 15 (10) (2014), pp. 1715-1723
13. E Caro-Morán, C Fernández-Lao, L Díaz-Rodríguez, I Cantarero-Villanueva, P Madeleine, M Arroyo-Morales Pressure pain sensitivity maps of the neck-shoulder region in breast cancer survivors *Pain Med*, 17 (10) (2016), pp. 1942-1952
14. N van Helmond, MA Steegers, GP Filippini-de Moor, KC Vissers, OH Wilder-Smith Hyperalgesia and persistent pain after breast cancer surgery: a prospective randomized controlled trial with perioperative COX-2 inhibition. *Dubois L, ed PLoS One*, 11 (12) (2016), Article e0166601
15. AA Juhl, P Karlsson, TE Damsgaard Fat grafting for alleviating persistent pain after breast cancer treatment: a randomized controlled trial *J Plast Reconstr Aesthet Surg*, 69 (9) (2016), pp. 1192-1202
16. T Field Massage therapy research review *Complement Ther Clin Pract*, 24 (2016), pp. 19-31
17. Chaitow L. *Fascial Dysfunction: Manual Therapy Approaches*. Edinburgh, Scotland: Handspring; 2014.
18. C Fernández-Lao, I Cantarero-Villanueva, C Fernández-de-Las-Peñas, R del Moral-Ávila, AM Castro-Sánchez, M Arroyo-Morales Effectiveness of a multidimensional physical therapy program on pain, pressure hypersensitivity, and trigger points in breast cancer survivors: a randomized controlled clinical trial *Clin J Pain*, 28 (2) (2012), pp. 113-121
19. E Castro-Martín, L Ortiz-Comino, T Gallart-Aragón, B Esteban-Moreno, M Arroyo-Morales, N Galiano-Castillo Myofascial induction effects on neck-shoulder pain in breast cancer survivors: randomized, single-blind, placebo-controlled crossover design *Arch Phys Med Rehabil*, 98 (5) (2017), pp. 832-840
20. I Cantarero-Villanueva, C Fernández-Lao, R Del Moral-Avila, C Fernández-de-Las-Peñas, MB Feriche-Fernández-Castanys, M Arroyo-Morales Effectiveness of core stability exercises and recovery myofascial release massage on fatigue in breast cancer survivors: a randomized controlled clinical trial *Evid Based Complement Alternat Med*, 2012 (2012), Article 620619
21. C Fernández-Lao, I Cantarero-Villanueva, L Díaz-Rodríguez, AI Cuesta-Vargas, C Fernández-Delas-Peñas, M Arroyo-Morales Attitudes towards massage modify effects of manual therapy in breast cancer survivors: a randomised clinical trial with crossover design *Eur J Cancer Care (Engl)*, 21 (2) (2012), pp. 233-241

22. C Fernández-Lao, I Cantarero-Villanueva, L Díaz-Rodríguez, C Fernández-de-las-Peñas, C Sánchez-Salado, M Arroyo-Morales The influence of patient attitude toward massage on pressure pain sensitivity and immune system after application of myofascial release in breast cancer survivors: a randomized, controlled crossover study *J Manipulative Physiol Ther*, 35 (2) (2012), pp. 94-100
23. L. Chaitow What's in a name: Myofascial release or myofascial induction *J Bodyw Mov Ther*, 21 (4) (2017), pp. 749-751
24. CG Gatlin, L. Schulmeister When medication is not enough: nonpharmacologic management of pain *Clin J Oncol Nurs*, 11 (5) (2007), pp. 699-704
25. A Running, T Seright Integrative oncology: managing cancer pain with complementary and alternative therapies *Curr Pain Headache Rep*, 16 (4) (2012), pp. 325-331
26. NL Nelson Massage therapy: understanding the mechanisms of action on blood pressure. A scoping review *J Am Soc Hypertens*, 9 (10) (2015), pp. 785-793
27. MH Rapaport, P Schettler, C Bresee A preliminary study of the effects of repeated massage on hypothalamic-pituitary-adrenal and immune function in healthy individuals: a study of mechanisms of action and dosage *J Altern Complement Med*, 18 (8) (2012), pp. 789-797
28. L Díaz-Rodríguez, AM Fernández-Pérez, N Galiano-Castillo, et al. Do patient profiles influence the effects of massage? A controlled clinical trial *Biol Res Nurs*, 18 (5) (2016), pp. 489-497
29. Law 14/2007, of July 3, on Biomedical Research Official Bulletin of the State (2011) No. 159 B-A-2007-12945
30. M Arroyo-Morales, C Fernández-Lao, A Ariza-García, et al. Psychophysiological effects of preperformance massage before isokinetic exercise *J Strength Cond Res*, 25 (2) (2011), pp. 481-488
31. A. Pilat *Myofascial Therapies: Myofascial Induction* McGraw-Hill Interamericana, Madrid (2003)
32. B. Minasny Understanding the process of fascial unwinding *Int J Ther Massage Bodyw*, 2 (3) (2009), pp. 10-17
33. P Tozzi, D Bongiorno, C Vitturini Fascial release effects on patients with non-specific cervical or lumbar pain *J Bodyw Mov Ther*, 15 (4) (2011), pp. 405-416
34. M Arroyo-Morales, N Olea, C Ruíz, et al. Massage after exercise—responses of immunologic and endocrine markers: a randomized single-blind placebo-controlled study *J strength Cond Res*, 23 (2) (2009), pp. 638-644
35. D. Butler *The Sensitive Nervous System* Noigroup Publications, Adelaide, Australia (2000)
36. RJ Nee, GA Jull, B Vicenzino, MW Coppieters The validity of upper-limb neurodynamic tests for detecting peripheral neuropathic pain *J Orthop Sports Phys Ther*, 42 (5) (2012), pp. 413-424
37. WD. Norkin *CC Measurement of Joint Motion: A Guide to Goniometry* (4th ed), FA Davis, Philadelphia (2009)
38. L Vanderweeën, RAB Oostendorp, P Vaes, W Duquet Pressure algometry in manual therapy *Man Ther*, 1 (5) (1996), pp. 258-265
39. M Sterling, J Treleaven, S Edwards, G Jull Pressure pain thresholds in chronic whiplash associated disorder: further evidence of altered

- central pain processing *J Musculoskelet Pain*, 10 (3) (2002), pp. 69-81
40. CA Moyer, J. Rounds The attitudes toward massage (ATOM) scale: reliability, validity, and associated findings *J Bodyw Mov Ther*, 13 (1) (2009), pp. 22-33
 41. SW Muir, CL Corea, L Beaupre Evaluating change in clinical status: reliability and measures of agreement for the assessment of glenohumeral range of motion *N Am J Sports Phys Ther*, 5 (3) (2010), pp. 98-110
 42. A De Groef, M Van Kampen, E Dieltjens, et al. Effectiveness of postoperative physical therapy for upper-limb impairments after breast cancer treatment: a systematic review *Arch Phys Med Rehabil*, 96 (6) (2015), pp. 1140-1153
 43. PJ Antolinos-Campillo, A Oliva-Pascual-Vaca, C Rodríguez-Blanco, AM Heredia-Rizo, V Espí-López G, F Ricard Short-term changes in median nerve neural tension after a suboccipital muscle inhibition technique in subjects with cervical whiplash: a randomised controlled trial *Physiotherapy*, 100 (3) (2014), pp. 249-255
 44. DE Ingber Tensegrity and mechanotransduction *J Bodyw Mov Ther*, 12 (3) (2008), pp. 198-200
 45. K Kassolik, A Jaskólska, K Kisiel-Sajewicz, J Marusiak, A Kawczyński, A Jaskólski Tensegrity principle in massage demonstrated by electro- and mechanomyography *J Bodyw Mov Ther*, 13 (2) (2009), pp. 164-170
 46. Pilat A. Manual therapy for musculoskeletal pain syndromes of the upper and lower quadrants: an evidence and clinical informed approach. In: Fernández de las Peñas C, Cleland JA DJ, eds. *Manual Therapy for Musculoskeletal Pain Syndromes of the Upper and Lower Quadrants: An Evidence and Clinical Informed Approach*. London: Elsevier; 2015.
 47. AT Masi, K Nair, T Evans, Y Ghandour Clinical, biomechanical, and physiological translational interpretations of human resting myofascial tone or tension *Int J Ther Massage Bodywork*, 3 (4) (2010), pp. 16-28
 48. J. Hromada On the nerve supply of the connective tissue of some peripheral nervous system components *Acta Anat (Basel)*, 55 (1963), pp. 343-351
 49. Thomas POY. Peripheral neuropathy. In: Dyck P, Thomas P, Lambert E BR, eds. *Textbook of Peripheral Neuropathy*. 2nd ed Philadelphia: Saunders; 1984.
 50. M Zusman, DA Edwards B Investigation of a proposed mechanism for the relief of spinal pain with passive joint movement *J Man Med*, 4 (1989), pp. 58-61
 51. A Wright Hypoalgesia post-manipulative therapy: a review of a potential neurophysiological mechanism *Man Ther*, 1 (1) (1995), pp. 11-16
 52. A Pilat Myofascial induction therapy (MIT) T Liem, P CA Tozzi (Eds.), *Fascia in Osteopahty*, Handspring, Edinburgh (2017)
 53. JE Bialosky, MD Bishop, DD Price, ME Robinson, SZ George The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model *Man Ther*, 14 (5) (2009), pp. 531-538
 54. JE Bialosky, JM Beneciuk, MD Bishop, et al. Unraveling the mechanisms of manual therapy: modeling an approach *J Orthop Sports Phys Ther*, 48 (1) (2018), pp. 8-18
 55. M Arroyo-Morales, N Olea, MM Martínez, A Hidalgo-Lozano, C Ruiz-Rodríguez, L Díaz-Rodríguez Psychophysiological effects of massage-myofascial release after exercise: a

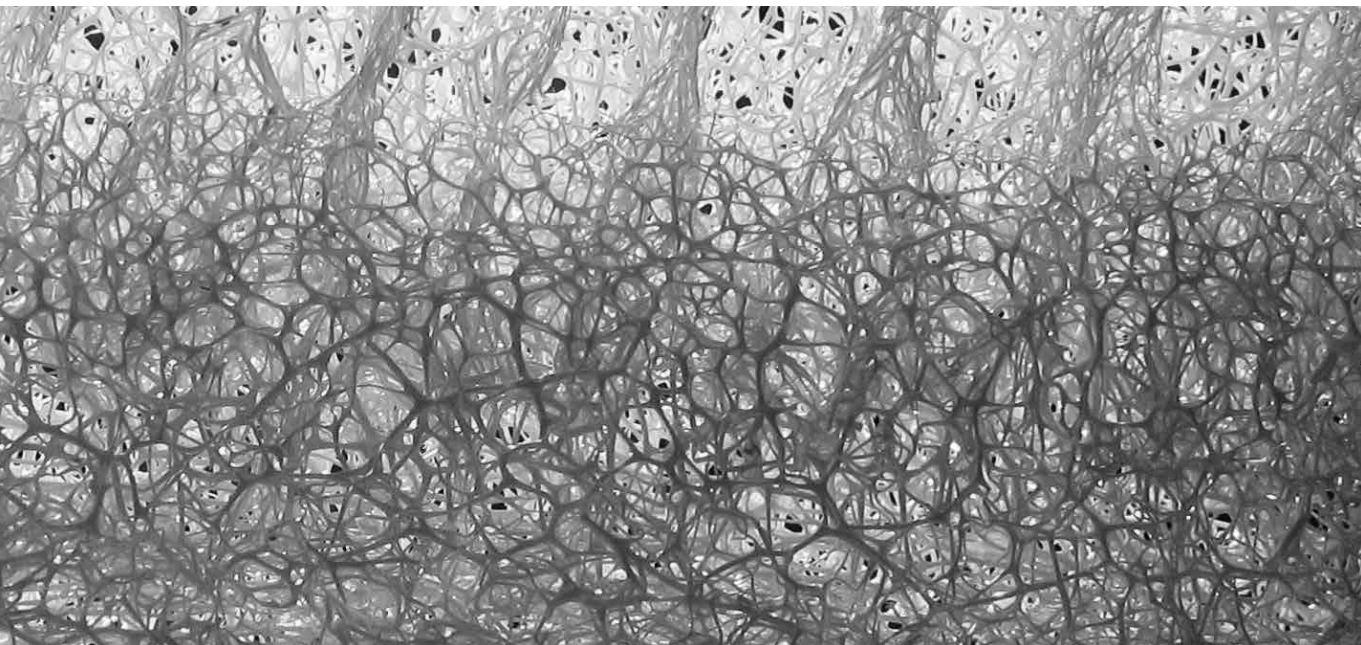
- randomized sham-control study J Altern Complement Med, 14 (10) (2008), pp. 1223-1229
56. AM Fernández-Pérez, MI Peralta-Ramírez, A Pilat, C Villaverde Effects of myofascial induction techniques on physiologic and psychologic parameters: a randomized controlled trial J Altern Complement Med, 14 (7) (2008), pp. 807-811
57. AM Heredia-Rizo, A Oliva-Pascual-Vaca, C Rodríguez-Blanco, F Piña-Pozo, A Luque-Carrasco, P Herrera-Monge Immediate changes in masticatory mechanosensitivity, mouth opening, and head posture after myofascial techniques in pain-free healthy participants: a randomized controlled trial J Manipulative Physiol Ther, 36 (5) (2013), pp. 310-318

ESTUDIO III

MYOFASCIAL INDUCTION THERAPY IMPROVES THE SEQUELAE OF MEDICAL TREATMENT IN HEAD AND NECK CANCER SURVIVORS: A SINGLE-BLIND, PLACEBO-CONTROLLED, RANDOMIZED CROSS-OVER STUDY

Journal of Clinical Medicine (2021)

Castro-Martín, E., Galiano-Castillo, N., Fernández-Lao, C., Ortiz-Comino, L., Postigo-Martin, P., & Arroyo-Morales, M. (2021). Myofascial Induction Therapy Improves the Sequelae of Medical Treatment in Head and Neck Cancer Survivors: A Single-Blind, Placebo-Controlled, Randomized Cross-Over Study. *Journal of clinical medicine*, 10(21), 5003. <https://doi.org/10.3390/jcm10215003>





ABSTRACT

Head and neck cancer (HNC) is the sixth most common cancer worldwide. Yet, less than 60% of HNC survivors receive adequate therapy for treatment-related sequelae. The objective of this study was to determine the efficacy of myofascial induction therapy (MIT) in improving cervical and shoulder pain and range of motion, maximal mouth opening, and cervical muscle function in HNC survivors. This crossover, blinded, placebo-controlled study involved 22 HNC survivors (average age 56.55 ± 12.71) of which 13 were males (59.1%) who received, in a crossover fashion, both a single 30-min session of MIT in the form of manual unwinding and simulated pulsed shortwave therapy (placebo), with a 4-week washout interval between the two. Cervical and shoulder pain (visual analogue scale) and range of motion (cervical range of motion device and goniometer), maximum mouth opening (digital caliper), and cervical muscle function (deep cervical flexor endurance test) were measured before and after the treatment and placebo sessions. A single session of MIT improved cervical and affected side shoulder pain, cervical range of motion, maximum mouth opening, and cervical muscle function. The associated effect sizes ranged from moderate to large. The present study suggests that MIT, in the form of manual unwinding, improves cervical (-3.91 ± 2.77) and affected-side shoulder (-3.64 ± 3.1) pain, cervical range of motion (flexion: 8.41 ± 8.26 deg; extension: 12.23 ± 6.55 ; affected-side rotation: 14.27 ± 11.05 ; unaffected-side rotation: 11.73 ± 8.65 ; affected-side lateroflexion: 7.95 ± 5.1 ; unaffected-side lateroflexion: 9.55 ± 6.6), maximum mouth opening (3.36 ± 3.4 mm), and cervical muscle function (8.09 ± 6.96 s) in HNC survivors.

Keywords: head and neck neoplasms, musculoskeletal manipulations, pain, range of motion

INTRODUCTION

Head and neck cancer (HNC) refers to any malignant tumor arising above the thoracic inlet and below the base of the skull. It therefore includes the oral cavity, pharynx, larynx, salivary glands and sinonasal cavities [1]. HNC is the sixth most common cancer worldwide; in 2019 more than 550,000 new cases were diagnosed. Its prevalence in men is twice that seen in women [2].

Tumor size, location and stage, guide the decision to treat via surgery and/or radiotherapy and chemotherapy; more advanced tumors commonly require combined treatments [3]. Surgical treatment involves tumor resection, plus neck dissection if the lymph nodes are affected. This procedure can leave sequelae such as pain and lack of mobility, leading to neck and shoulder dysfunction [4]. For its part, cumulative radiotherapy can generate fibrosis, soft tissue necrosis and osteoradionecrosis [5], and chemotherapy can induce sensory and motor disorders [6]. The risk of developing significant functional deficiencies is even higher with concurrent chemoradiotherapy [7].

Treatment-induced pain in the neck and shoulder is common in survivors of HNC. In fact, some 70% of patients are affected by the end of treatment, as are over 35% at six months post-completion [8], and indeed over the first three years after diagnosis [9]. This pain is mainly considered nociceptive, but it may also be neuropathic in origin and involve peripheral and central sensitization processes [10]. Similarly, motor function in this region and in any treated adjacent region may worsen. For example, neurological damage and fibrotic changes may appear at surgery and radiotherapy sites, resulting in a reduction in cervical and shoulder range of motion (ROM) and maximum mouth opening (MMO) (including trismus), and causing difficulty in activating

certain muscle groups [11,12]. The latter has been described in survivors of breast cancer, in whom altered patterns of cervical muscle activation were detected during functional upper limb tasks [13]. Yet, despite all this being known, less than 60% of all survivors of HNC receive adequate therapy for these sequelae [14].

Physical therapy should be provided throughout cancer care [15]. Multiple body systems (cardiovascular, musculoskeletal, joints or nervous system) could be affected by cancer itself and medical treatment. In this sense, physical therapy is helpful and could contribute to address these harmful effects [16]. In particular, manual therapy has been associated with improved blood circulation, reduced muscle spasms, increased ROM, the release of connective tissue adhesions, reduced pain and restoring mobility [17,18]. Specifically, in survivors of HNC manual therapy showed no specific adverse outcomes [19], reporting adverse events similar to those experienced by patients without cancer [20].

Myofascial induction therapy (MIT) can assist in eliminating functional limitations by helping to restore general health and reducing or eliminating pain. Taking into account that the origin of sequelae could be multiple and so different areas could be damaged, MIT would be the most suitable manual technique to influence other areas at some distance, owing to its systemic effects (theory of tissue tensegrity) [21]. For example, it has been shown to reduce pain and improve cervical and shoulder ROM in patients with breast cancer [22,23,24,25]. In addition, it can help the function of scarred areas once the remodeling process is complete [26]. However, no evidence has been collected to show that MIT reduces pain resulting from medical treatment in survivors of HNC, and while one report suggests it can improve MMO and cervical muscle function, this did not involve patients with

cancer [27]. Given this background, the aim of the present work was to determine the immediate effects of MIT on cervical and shoulder pain, cervical and shoulder ROM, MMO and cervical muscle function in survivors of HNC with neck/shoulder morbidity in compared with placebo pulsed shortwave therapy. We hypothesized that MIT would improve all outcomes described due to the fact that all of them are sequelae well described by survivors of HNC.

MATERIALS AND METHODS

Study Design

This study was designed as a single-blind, placebo-controlled, cross-over trial (ClinicalTrials.gov NCT04145180). This type of design allows inter-individual variation in outcome measures to be taken into account [22,23] and adheres to the CONSORT 2010 statement “extension to randomized crossover trials” [28] (Supplementary Table S1).

Participants

Twenty-two survivors of HNC were recruited from the Oncology and Maxillofacial units of the Virgen de las Nieves Hospital (Granada, Spain) between November 2019 and March 2020. To be eligible for inclusion, patients had to: (1) have had a diagnosis of HNC (stage I-IV) [29]; (2) be between 25 and 85 years of age; (3) have completed adjuvant therapy, and (4) perceive pain at a value of >3 on a 0–10 visual analogue scale (VAS). Patients were excluded if they: (1) had a recurrent cancer, (2) had suffered trauma or surgery in the oro-facial, cervical, thoracic or upper limb areas not related to cancer in the last 6 months, or (3) did not have medical clearance to participate.

A total of 22 patients were randomized (Figure 1). Thirteen of the 22 patients were male (59.1%) and 9 female (40.9%). Many patients were diagnosed with stage IV disease (40.9%). In total, some 95.4% of the subjects underwent surgery, 95.5% underwent radiotherapy and 68.2% underwent chemotherapy. The mean time elapsed since the diagnosis of cancer

was 26.33 months. According to the Fonseca Anamnesis Index [30], three patients (13.6%) had no temporomandibular disorder (TMD), 4 (18.2%) had mild TMD, 6 (27.3%) had moderate TMD, and 9 (40.9%) had severe TMD. Table 1 shows the remaining demographic and clinical data collected. No adverse effects were recorded.

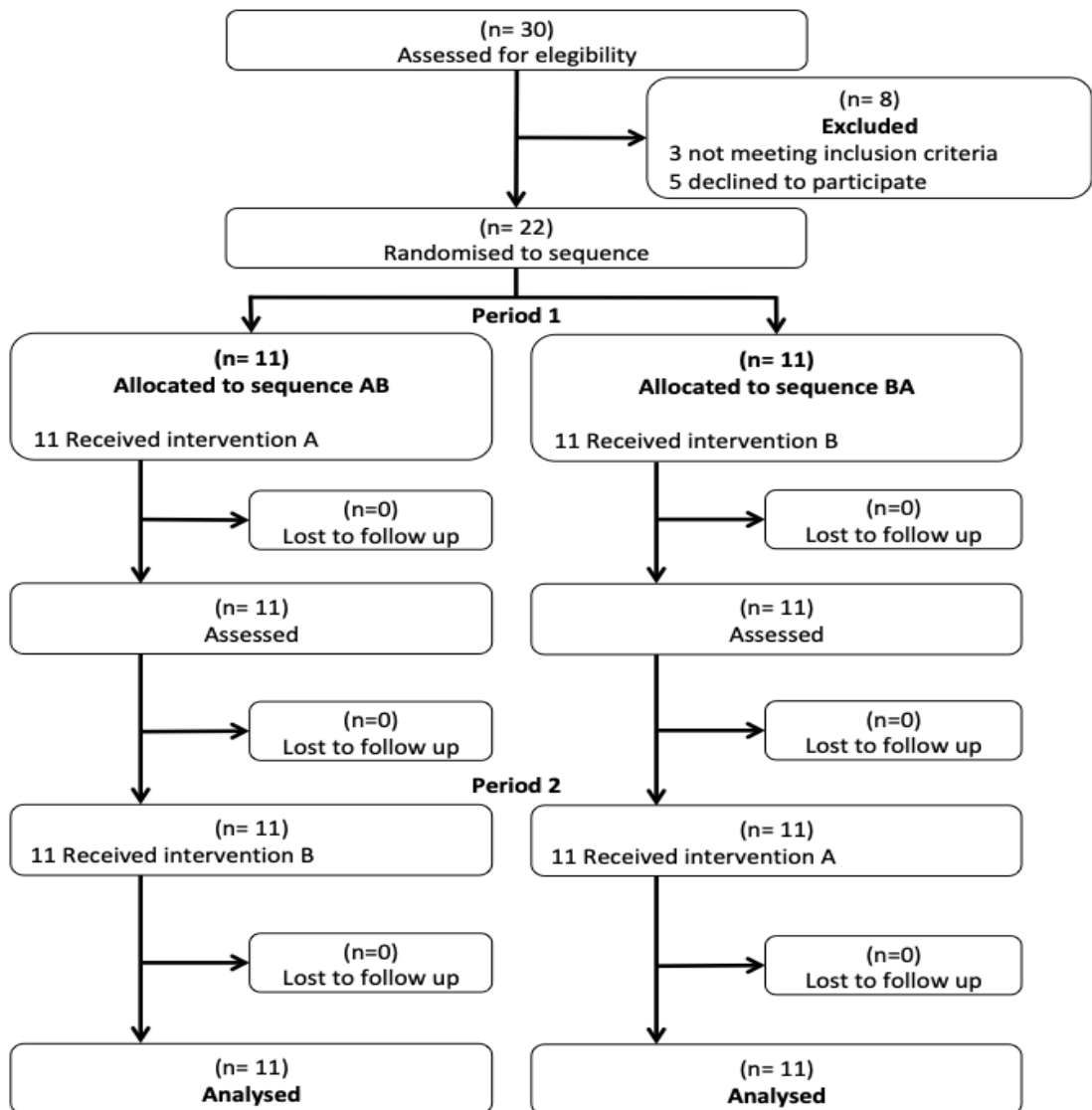


Figure 1. Flowchart according to CONSORT statement for the report of randomized trials.

Table 1. Baseline demographic and clinical data (n=22)

Age (y)	56.55 (12.71)
Gender	
Male	13 (59.1)
Female	9 (40.9)
Alcohol consumption	
None	12 (54.5)
Monthly	4 (18.2)
Weekly	4 (18.2)
Daily	2 (9.1)
Smoking habits	
Non smoker	8 (36.4)
Ex-smoker	11 (50)
Smoker	3 (13.6)
Time since diagnosis (months)	26.33 (16.68)
Affected-side	
Right	11 (50)
Left	11 (50)
Cancer stage	
I	5 (22.7)
II	3 (13.6)
III	3 (13.6)
IV	9 (40.9)
Surgery	
None	1 (4.5)
MRND	9 (40.9)
RND	12 (54.5)
Radiotherapy	
No	1 (4.5)
Yes	21 (95.5)
Chemotherapy	
No	7 (31.8)
Yes	15 (68.2)
Fonseca	
None	3 (13.6)
Light	4 (18.2)
Moderate	6 (27.3)
Severe	9 (40.9)

Sample Size

The required sample size—for 80% power to detect a mean difference of 1.5 pain VAS points with a standard deviation of 3 points, a type 1 error (α) of 7.5%, and a type 2 error (β) of 20%—was calculated as previously described [22] and using the EPIDAT 3.1 software (Xeral de Saúde Pública, La Coruña, Spain). This determined the need for 20 patients in total; 22 were recruited to account for possible dropouts. The total trial finished once the sample size was reached.

Randomization to Treatment/Control Group, and Treatment Cross-Over

All patients were subject to one session of MIT in the form of myofascial unwinding (MU) for 30 min, and to mock pulsed shortwave therapy (placebo) for 30 min, separated by a four-week wash-out interval before cross-over. All interventions were performed by the same physical therapist in a physical therapy laboratory at the Health Science Faculty, University of Granada, Spain. The order of MIT/placebo treatment was decided by coin flipping (performed by a clinician blinded to the study). MU was performed as previously described [22] (Figure 2a–d); this is a safe and effective technique for restoring tissue mobility and function [22]. With the patient in the supine position, the physical therapist lifted the head, applied gentle and sustained traction, and moved the head as previously described [22]. The mock pulsed shortwave therapy for the placebo treatment was administered as previously described [22,23]. All sessions were conducted at the same time of day at 20–22 °C in a physical therapy laboratory.



a)



b)



c)



d)

Figure 2. (a–d). Myofascial unwinding description over the neck area.

Outcome Measures

Values for all measured variables were recorded immediately before and after the treatment and placebo sessions.

Pain The 0–10 VAS mentioned above was used to evaluate perceived pain in the cervical and shoulder regions. This scale has been widely used and has been demonstrated to be reliable and valid. It is commonly used to measure pain in different populations, including survivors of HNC [31].

Range of Motion To determine the cervical ROM (which includes the variables flexion, extension, affected-side rotation, unaffected-side rotation, affected-side lateroflexion and unaffected-side lateroflexion), patients were placed in a sitting position with their feet on the floor. A cervical

range of motion (CROM) device (Performance Attainment Associates, Spine Products, Roseville, MN, USA) was used for this measurement. The intraclass correlation coefficient (ICC) for the CROM device ranges from 0.89 to 0.98 for the cervical ROM variables. Test-retest reliability of measurements was assessed, as well as its standard error of measurement and minimal detectable change, with 2 measures taken on 2 separate days spaced 48 h apart [32].

A plastic universal goniometer with two adjustable overlapping arms was used to measure shoulder ROM, including active flexion, abduction, and external and internal rotation (all for both the affected and unaffected sides). The ICC is ≥ 0.94 for the assessed shoulder joint movements. Intra-rater (2 measurements performed with a lapse of 24 h in between) and inter-rater reliability (2 measu-

rements performed on the same day) have been evidenced, as well as its standard error of measurement and the minimal detectable change [33].

Maximum Mouth Opening Patients, sitting in an upright position, were requested to open the mouth as widely as possible without pain, and the distance between the incisal margins of the central maxillary and mandibular incisors was measured using an ABS Hoxel digital caliper (Hoffmann-Group, Munich, Germany) (resolution 0.01 mm, nominal capacity 150 mm, accuracy of ± 0.02 mm). An ICC of 0.85–0.96 has been reported for this test [34].

Cervical Muscle Function The activity of the deep cervical flexor muscles was recorded using the deep cervical flexor endurance test (DCFET) (Figure 3). Patients were positioned supine on the treatment table. The therapist placed a hand under the patient's head and requested that he/she execute a cervical flexion by making a "double chin" and lifting the head as little as possible to lose contact with the therapist's hand. Time was measured from the moment the patient started the movement until: (1) the movement was lost (2) the head touched the therapist's hand for more than a second, (3) the subject began to feel pain. An ICC of 0.82–0.91 has been reported for this test [35].



Figure 3. Deep cervical flexor endurance test description over the neck area.

Statistical Analysis

Data were expressed as means and standard deviations (continuous data) or frequencies and percentages (categorical data). The normality of all variables was tested using the Kolmogorov–Smirnov test. The values of non-parametric variables were logarithmically transformed before use. Baseline differences for continuous variables between the MIT and placebo sessions were analyzed using the Student t-test or Mann Whitney U test as appropriate; the Chi2 test or Fisher's exact test was used for categorical variables. To examine the effects of the MIT and placebo treatments, two-way repeated measures analysis of variance (ANOVA) was performed, using the treatments as the between-group variable, and time (pre–post treatment) as the within-group variable. If an interaction was found to have a significant influence, pairwise comparison was performed to determine whether the between-group difference in score change was also significant. Pairwise comparisons were corrected by multiplying the obtained p value by 4 (i.e., for 2 treatments at 2 different times). Effect sizes were calculated as Cohen's d values. Significance was set at $p < 0.05$. Wherever possible, the results were examined in terms of clinically meaningful change. All calculations were made using SPSS software v.25.0 (IBM Statistics, Armonk, NY, USA).

Ethics Statement

The study was approved by the Ethics Committee of the University of Granada (CEI-GRANADA Ref: 0045-N-16) and was performed according to the guidelines established by the Helsinki Declaration and Law 14/2007 on Biomedical Research. All subjects received written information regarding the study and gave their informed consent to be included.

RESULTS

Effects of MIT on Cervical and Shoulder Pain

The interaction time (i.e., pre or post treatment) $\times$ treatment had a significant, positive influence on cervical ($F = 5.310$; $p = 0.026$) and affected-side shoulder ($F = 13.457$; $p = 0.001$) pain. However, it had no influence on the unaffected shoulder ($F = 0.025$; $p = 0.876$) (Table 2). Pairwise comparisons revealed a significant reduction in the cervical (-3.91 points) and affected-side

shoulder (-3.64 points) pain scores after the MIT session (all $p < 0.004$), and in cervical pain (-2.09) after the placebo session ($p < 0.004$), although the latter change did not reach the minimum required to be clinically meaningful (3 points) [36]. After the MIT session, 15 patients (68.2%) saw their scores surpass this threshold with respect to cervical pain, and 16 (72.7%) with respect to affected-side shoulder pain. The effect size of MIT was moderate for cervical pain ($d = -0.70$, 95%CI -1.29 ; -0.08) and large for affected-side shoulder pain ($d = -1.11$, 95%CI -1.72 ; -0.45).

Table 2. Preintervention, postintervention, and change scores for VAS (n=22)

VAS	MIT session	Placebo Session	<i>p</i> value*
VAS cervical			<i>p</i> =0.026
Preintervention	5.32 $\pm$ 2.43	5.68 $\pm$ 2.47	
Postintervention	1.41 $\pm$ 2.30	3.59 $\pm$ 2.70	
Pre-post change score	-3.91 $\pm$ 2.77 [†]	-2.09 $\pm$ 2.45 [†]	
VAS affected-side shoulder			<i>p</i> =0.001
Preintervention	4.41 $\pm$ 2.93	4.55 $\pm$ 2.89	
Postintervention	0.77 $\pm$ 1.92	3.95 $\pm$ 3.06	
Pre-post differences	-3.64 $\pm$ 3.11 [†]	-0.59 $\pm$ 2.36	
VAS unaffected-side shoulder			<i>p</i> =0.876
Preintervention	1.55 $\pm$ 2.80	2.32 $\pm$ 3.19	
Postintervention	0.36 $\pm$ 1.33	1.27 $\pm$ 2.58	
Pre-post differences	-1.18 $\pm$ 2.34	-1.05 $\pm$ 3.33	

Values are mean $\pm$ SD at preintervention and postintervention. The mean difference $\pm$ SD for pre-post change score.

*Interaction *time $\times$ treatment* (ANOVA analysis). [†]Significant pairwise comparisons ($p < 0.05$). MIT: Myofascial induction therapy; VAS: Visual Analogue Scale.

Effects of MIT on Cervical and Shoulder Range of Movement

The interaction time $\times$ treatment had a significant, positive influence on all cervical ROM variables: flexion ($F = 10.589$; $p = 0.002$), extension ($F = 53.850$; $p < 0.001$), rotation on the affected side ($F = 22.471$; $p < 0.001$), rotation

on the unaffected side ($F = 25.217$; $p < 0.001$), lateral flexion on the affected side ($F = 25.217$; $p < 0.001$) and lateral flexion on the unaffected side ($F = 9.764$; $p = 0.003$) (Table 3). Moreover, pairwise comparisons indicated a significant increase in the values of all cervical ROM variables following MIT (all $p < 0.004$); after the placebo session, values were either maintained or

reflected a worsening. All changes in cervical ROM values surpassed the minimum threshold for clinically meaningful change (reference range of 3.6–6.5 degrees⁹) [32]. The effect size of MIT on the cervical ROM variables was always large: flexion ($d = 0.98$, 95%CI 0.34–1.59), exten-

sion ($d = 2.21$, 95%CI 1.43–2.92), affected-side rotation ($d = 1.43$, 95%CI 0.74–2.06), unaffected-side rotation ($d = 1.45$, 95%CI 0.76; 2.09), affected-side lateral flexion ($d = 1.51$, 95%CI 0.82–2.15), unaffected-side lateral flexion ($d = 1.45$, 95%CI 0.76–2.09).

Table 3. Preintervention, postintervention, and change scores for cervical ROM (n=22)

Cervical ROM (deg)	MIT session	Placebo Session	p value*
Flexion (deg)			$p=0.002$
Preintervention	47.18±9.56	43.82±13.12	
Postintervention	55.59±9.06	43.41±12.28	
Pre-post change score	8.41±8.26†	-0.41±9.66	
Extension (deg)			$p<0.001$
Preintervention	43.86±15.04	46.27±15.27	
Postintervention	56.09±14.93	41.95±15.28	
Pre-post change score	12.23±6.55†	-4.32±8.3	
Affected-side rotation (deg)			$p<0.001$
Preintervention	51.00±15.84	51.73±12.43	
Postintervention	65.27±12.87	52.14±16.38	
Pre-post change score	14.27±11.05†	0.41±8.12	
Unaffected-side rotation (deg)			$p<0.001$
Preintervention	51.41±15.25	51.45±15.70	
Postintervention	63.14±10.03	50.68±12.46	
Pre-post change score	11.73±8.65†	-0.77±8.56	
Affected-side lateroflexion (deg)			$p<0.001$
Preintervention	30.14±9.04	31.64±11.35	
Postintervention	38.09±8.77	29.55±8.76	
Pre-post change score	7.95±5.1†	-2.09±7.88	
Unaffected-side lateroflexion (deg)**			$p=0.003$
Preintervention	30.75±9.39	32.73±11.47	
Postintervention	38.32±10.06	29.36±9.51	
Pre-post change score	9.55±6.6†	-3.36±10.71	

Values are mean ± SD at preintervention and postintervention. The mean difference ± SD for pre-post change score.

*Interaction *time x treatment* (ANOVA analysis). †Significant pairwise comparisons ($p<0.05$). **Logarithmically transformed. Deg: degrees; MIT: Myofascial induction therapy; VAS: Visual Analog Scale; ROM: range of motion.

The interaction time $\times$ treatment also had a significant, positive influence on the affected-side external rotation ($F = 4.098$; $p = 0.049$). No such influence was seen with respect to flexion, abduction and internal rotation for either side, or unaffected-side external rotation (all $p > 0.05$) (Table

4). In pairwise comparisons, no significant difference was seen in affected-side external rotation ($p > 0.05$); indeed, the minimum threshold for clinically meaningful change for shoulder ROM (reference range of 14–24 degrees) was not reached after either the MIT or placebo sessions [37].

Table 4. Preintervention, postintervention, and change scores for shoulder ROM (n=22)

Shoulder ROM (deg)	MIT session	Placebo Session	p value*
Affected-side flexion (deg)			$p=0.080$
Preintervention	152.86 $\pm$ 25.23	142.23 $\pm$ 29.51	
Postintervention	161.41 $\pm$ 23.28	144.86 $\pm$ 31.63	
Pre-post change score	8.55 $\pm$ 7.63	2.64 $\pm$ 13.45	
Unaffected-side flexion (deg)			$p=0.900$
Preintervention	161.05 $\pm$ 18.04	154.10 $\pm$ 20.78	
Postintervention	161.27 $\pm$ 21.15	154.32 $\pm$ 25.14	
Pre-post change score	3.61 $\pm$ 6.86	3.28 $\pm$ 9.86	
Affected-side abduction (deg)			$p=0.362$
Preintervention	138.09 $\pm$ 34.01	126.36 $\pm$ 43.28	
Postintervention	148.09 $\pm$ 35.73	131.27 $\pm$ 42.71	
Pre-post change score	10 $\pm$ 17.32	4.91 $\pm$ 19.24	
Unaffected-side abduction (deg)			$p=0.731$
Preintervention	151.43 $\pm$ 33.80	132.14 $\pm$ 41.23	
Postintervention	154.41 $\pm$ 27.30	139.36 $\pm$ 37.58	
Pre-post change score	5.10 $\pm$ 10.70	7.23 $\pm$ 26.18	
Affected-side external rotation (deg)			$p=0.049$
Preintervention	67.05 $\pm$ 24.08	73.18 $\pm$ 22.65	
Postintervention	74.05 $\pm$ 21.39	73.86 $\pm$ 22.63	
Pre-post change score	7 $\pm$ 11.20	0.68 $\pm$ 9.41	
Unaffected-side external rotation (deg)			$p=0.671$
Preintervention	72.76 $\pm$ 22.68	74.64 $\pm$ 18.75	
Postintervention	71.27 $\pm$ 22.97	73.36 $\pm$ 20.76	
Pre-post change score	0.48 $\pm$ 10.15	-1.27 $\pm$ 15.88	
Affected-side internal rotation (deg)			$p=0.156$
Preintervention	71.77 $\pm$ 15.55	67.32 $\pm$ 18.12	
Postintervention	76.55 $\pm$ 16.03	67.68 $\pm$ 18.34	
Pre-post change score	4.77 $\pm$ 8.04	0.36 $\pm$ 11.84	
Unaffected-side internal rotation (deg)			$p=0.130$
Preintervention	73.38 $\pm$ 14.92	75.45 $\pm$ 19.20	
Postintervention	70.73 $\pm$ 18.09	67.73 $\pm$ 23.04	
Pre-post change score	-0.71 $\pm$ 7.77	-7.73 $\pm$ 19.33	

Values are mean $\pm$ SD at preintervention and postintervention. The mean difference $\pm$ SD for pre-post change score.

*Interaction time $\times$ treatment (ANOVA analysis). Deg: degrees; MIT: Myofascial induction therapy; VAS: Visual Analog Scale; ROM: range of motion.

Effects of MIT on Maximum Mouth Opening and Cervical Muscle Function

The interaction time x treatment had a significant influence on MMO ($F = 17.153$; $p < 0.001$) (Table 5). Pairwise comparisons revealed that after MIT, MMO improved significantly (score change +3.36 mm; $p < 0.004$), but not after the placebo session (score change -0.36). The same interaction also had a significant influence on cervical muscle function ($F = 25.081$; $p < 0.001$)

(Table 5). In addition, pairwise comparisons showed a significant improvement in cervical muscle function after the MIT session (score change +8.09 s; $p < 0.004$); after the placebo session the score became slightly worse (score change -0.63 s). However, the minimum change in neck pain required to be clinically meaningful (19.05 s in the DCFET [38]) was not surpassed. The effect size for MIT was large, both for MMO ($d = 1.25$ 95%CI 0.58; 1.87) and cervical muscle function ($d = 1.51$ 95%CI 0.82; 2.15).

Table 5. Preintervention, postintervention, and change scores for MMO and DCFET (n=22)

	MIT session	Placebo Session	p value*
MMO (mm)			$p < 0.001$
Preintervention	33.14±10.96	30.05±10.21	
Postintervention	36.5±11.55	29.68±11.33	
Pre-post change score	3.36±3.4†	-0.36±2.50	
DCFET (s)			$p < 0.001$
Preintervention	11.10±7.95	9.70±7.53	
Postintervention	19.19±10.05	9.07±7.86	
Pre-post change score	8.09±6.96†	-0.63±4.26	

Values are mean ± SD at preintervention and postintervention. The mean difference ± SD for pre-post change score. *Interaction *time x treatment* (ANOVA analysis). †Significant pairwise comparisons ($p < 0.05$). DCFET: Deep cervical flexor endurance test; s: seconds; mm: millimeters; MIT: Myofascial induction therapy; MMO: Maximal mouth opening

DISCUSSION

The present results show that a single session of MIT in the form of MU improves pain, cervical ROM, MMO and cervical muscle function in survivors of HNC, with the effect size on these variables ranging from moderate to large. A single session does not, however, improve shoulder ROM in these patients.

Following the MIT session, the patients experienced a significant reduction in pain in the cervical area and the affected-side shoulder, with most showing a clinically meaningful difference

(an improvement of >3 points) for both impairments (68.2% and 72.7%, respectively) [36]. The placebo session also led to a significant reduction in pain in the cervical region, perhaps due to some relaxation that the patients interpreted as a reduction in pain, but this was not clinically meaningful. Some studies report a single session of manual therapy to be beneficial in terms of pain relief, including MIT in patients with cervical or shoulder pain [22,23,24]. Fascial induction is used to treat fascial restriction and to restore tissue function [39], which might aid in pain reduction. Certainly, different massage techniques, including MIT techniques, have been used to

treat patients with cancer to alleviate pain [22], and a systematic review indicates that different types of massage provide a safe and effective treatment for pain compared to no-treatment in such patients [40]. The present results would seem to endorse the idea that survivors of HNC also benefit from manual massage.

The single session of MIT also improved cervical ROM (all variables), with values surpassing the threshold of clinical significance [32]. MIT protocols have been shown effective in treating restrictions affecting the neck and shoulder in patients with cancer [22,24]. As suggested in our previous work [22,23], MU could promote a neurobiological response through stimulation of intrafascial mechanoreceptors, leading to the functional improvement of affected tissues. It should be noted that the present single session of MIT provided no benefit in terms of shoulder ROM.

The single MIT session significantly improved MMO. It is known that the range of mouth opening measured should include pain-free MMO for the diagnosis of mandibular disorders [41]. Indeed, this improvement was clinically meaningful: the mean MMO for the MIT-treated patients was above 35 mm, the upper threshold for trismus [42]. Many survivors of HNC experience difficulty in opening their mouths. Some authors have reported intraoral myofascial release to be effective in treating mouth opening in subjects with temporomandibular disorders [43], but to our knowledge no previous study has examined treating survivors of HNC via MIT. In the present work, one session of MIT in the form of MU focused on the cervical region, increased MMO. This may be explained by the dynamic biomechanical relationship that exists between the cervical spine and the temporomandibular joint during active mouth opening [44]. It has been reported that manual therapy of the cervical region increases active

mouth opening in patients with temporomandibular disorders [45]. Suboccipital myofascial induction led to an immediate increase in pressure pain thresholds over latent trigger points in the masseter and temporalis muscles and an increase in MMO in non-oncological subjects [27]. Alternatively, stimulation in the cervical region might activate descending inhibitory pathways involving the cervical and trigeminal areas; via the trigemino-cervical nucleus, this might then improve cervical and oro-facial muscle behavior by ameliorating mandibular dynamics. MU might also generate changes in positional afferent inputs into the cervical spine, and thus improve the biomechanical relationship between the latter and the temporomandibular joint, increasing mouth opening [45].

The present results also show the effectiveness of the MIT technique used in increasing cervical muscle endurance (as determined by DFCET). In agreement with this, other authors have reported the effectiveness of manual therapy in improving isometric cervical strength in subjects with mechanical neck pain [46]. It is likely that the cervical muscle dysfunction that occurs in many patients who have survived HNC is related to structural changes [47]. The reduced neck pain in the present patients after MIT suggests this treatment may improve the isometric strength of deep cervical flexors. However, the improvement in muscle endurance did not reach the threshold of clinically meaningful change established for neck pain [38]. It may be that a single session of MIT is insufficient. More treatment sessions might be required to achieve the desired results.

The current work has several limitations. Firstly, the sample size, although sufficiently large for the present work, was small. A larger sample may have reduced interindividual differences. Secondly, only one treatment session was provided. More treatment sessions might have

improved the results obtained. The fact that an improvement in pain was recorded for the affected-side shoulder, but not that shoulder's ROM, suggests the results should be interpreted with caution. Further, all treatment was provided by the same physical therapist; while this may offer certain advantages in the research setting, it should be borne in mind that different practitioners might obtain different results in the clinical setting. Further experiments with more practitioners might throw light on the suitability of MIT in a setting more similar to routine clinical practice. To avoid all these limitations, future research should focus on performing studies with larger sample sizes, longer interventions and different physical therapists to evidence and clarify the effects of MIT in survivors of HNC.

CONCLUSIONS

The present results show the effectiveness of a single session of MIT in improving pain, cervical ROM, MMO and cervical muscle function, but not shoulder ROM, in survivors of HNC. Future work should involve more sessions to determine whether the results can be improved, as well as more physical therapists in order to better simulate the clinical setting.

Acknowledgments

The authors thank all individuals who participated in this study. We also thank Adrian Burton for language and editing assistance.

Author Contributions

Conceptualization, E.C.-M. and N.G.-C.; data curation, M.A.-M., C.F.-L. and N.G.-C.; funding acquisition, M.A.-M. and N.G.-C.; investigation, E.C.-M., L.O.-C.; methodology, C.F.-L., E.C.-M.,

P.P.-M., N.G.-C.; project administration, C.F.-L.; writing-original draft, C.F.-L., E.C.-M., L.O.-C. and N.G.-C.; writing-review and editing, M.A.-M., P.P.-M., C.F.-L., E.C.-M., L.O.-C. and N.G.-C. All authors have read and agreed to the published version of the manuscript.

Funding

This study was financed by the European Regional Development Fund (ERDF) and the "University of Granada, Excellence Actions: Units of Excellence; Unit of Excellence on Exercise and Health (UCEES)" program. This work was part of a PhD thesis conducted within the Clinical Medicine and Public Health Doctoral Studies Program of the University of Granada, Spain. This work was supported by the University of Granada: "Proyectos de Investigación Precompetitivos para Jóvenes Investigadores. Plan Propio 2020" Code: PPJA2020.15.

Institutional Review Board Statement

The study was approved by the ethics committee of the University of Granada (CEi-GRANADA Ref: 0045-N-16) and was performed according to the guidelines established by the Helsinki Declaration and Spanish Law 14/2007 on Biomedical Research. All participants gave written informed consent before data collection began. ClinicalTrials.gov NCT04145180.

Informed Consent Statement

All subjects received written information regarding the study and gave their informed consent to be included. Written informed consent has been obtained from the patients to publish this paper.

Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

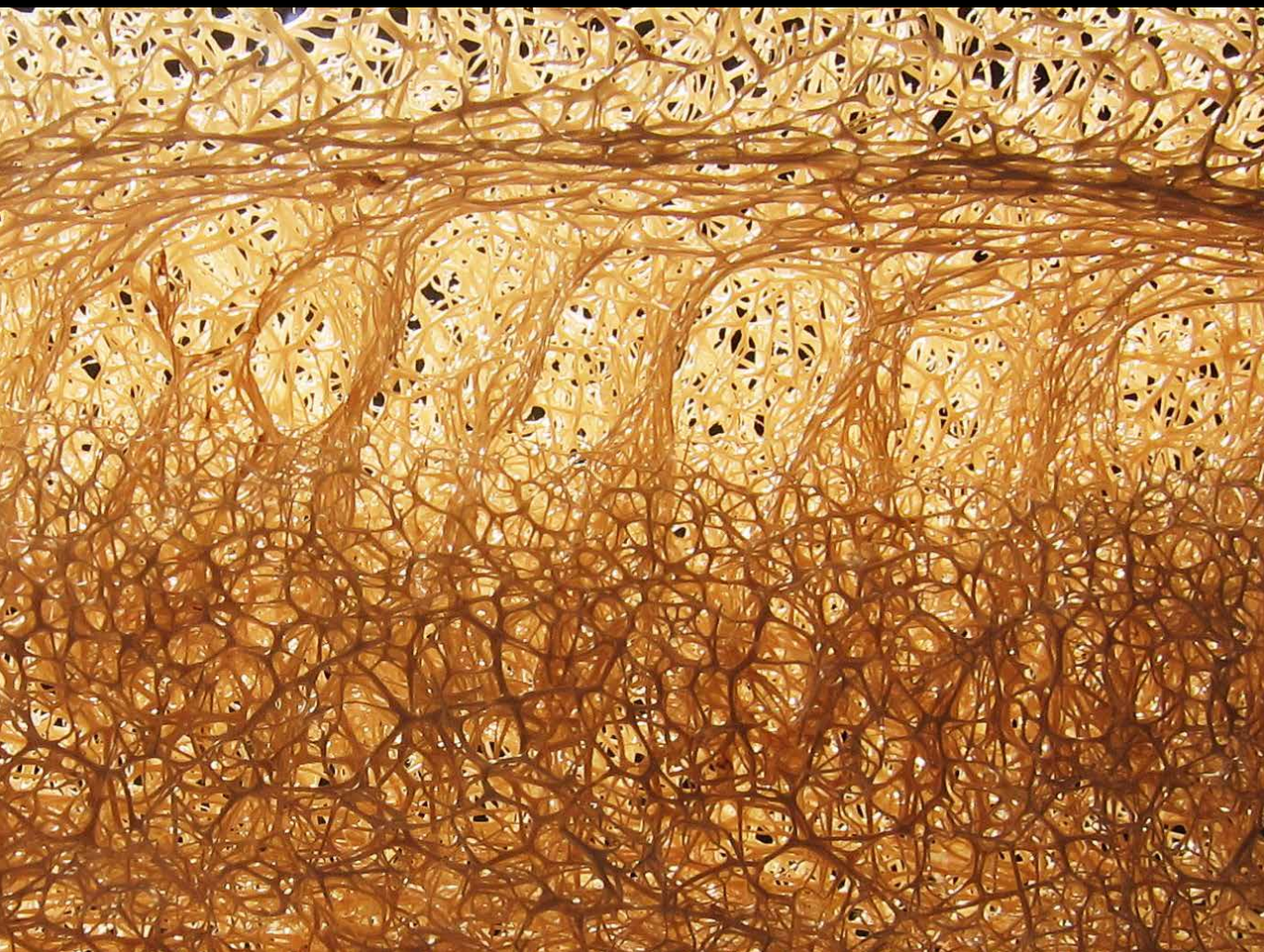
1. Cohen N., Fedewa S., Chen A.Y. Epidemiology and Demographics of the Head and Neck Cancer Population. *Oral Maxillofac. Surg. Clin. N. Am.* 2018;30:381-395. doi: 10.1016/j.coms.2018.06.001.
2. Aupérin A. Epidemiology of Head and Neck Cancers: An Update. *Curr. Opin. Oncol.* 2020;32:178-186. doi: 10.1097/CCO.0000000000000629.
3. Shah J., Patel S., Singh B., Wong R. *Head and Neck Surgery and Oncology*. 5th ed. Elsevier; Amsterdam, The Netherlands: 2019.
4. Gane E.M., Michaleff Z.A., Cottrell M.A., McPhail S.M., Hatton A.L., Panizza B.J., O'Leary S.P. Prevalence, Incidence, and Risk Factors for Shoulder and Neck Dysfunction after Neck Dissection: A Systematic Review. *Eur. J. Surg. Oncol.* 2017;43:1199-1218. doi: 10.1016/j.ejso.2016.10.026.
5. Maghami E., Ho A. *Multidisciplinary Care of the Head and Neck Cancer Patient*. Springer International Publishing; Berlin/Heidelberg, Germany: 2018.
6. Baggi F., Santoro L., Grosso E., Zanetti C., Bonacossa E., Sandrin F., Massaro M.A., Tradedati N., Simoncini M.C. Recupero Motorio e Funzionale Dopo Dissezione Latero-Cervicale Del Collo: Due Programmi Di Fisioterapia Precoce a Confronto. *Acta Otorhinolaryngol. Ital.* 2014;34:230-240.
7. Huang J., Zhang J., Shi C., Liu L., Wei Y. Survival, Recurrence and Toxicity of HNSCC in Comparison of a Radiotherapy Combination with Cisplatin versus Cetuximab: A Meta-Analysis. *BMC Cancer.* 2016;16:1-16. doi: 10.1186/s12885-016-2706-2.
8. Bossi P., Giusti R., Tarsitano A., Airolidi M., De Sanctis V., Caspiani O., Alterio D., Tartaro T., Alfieri S., Siano M. The Point of Pain in Head and Neck Cancer. *Crit. Rev. Oncol./Hematol.* 2019;138:51-59. doi: 10.1016/j.critrevonc.2019.04.001.
9. Cramer J.D., Johnson J.T., Nilsen M.L. Pain in Head and Neck Cancer Survivors: Prevalence, Predictors, and Quality-of-Life Impact. *Otolaryngol.-Head Neck Surg.* 2018;159:853-858. doi: 10.1177/0194599818783964.
10. Ortiz-Comino L., Fernández-Lao C., Castro-Martín E., Lozano-Lozano M., Cantarero-Villanueva I., Arroyo-Morales M., Martín-Martín L. Myofascial Pain, Widespread Pressure Hypersensitivity, and Hyperalgesia in the Face, Neck, and Shoulder Regions, in Survivors of Head and Neck Cancer. *Support. Care Cancer.* 2020;28:2891-2898. doi: 10.1007/s00520-019-05173-6.
11. Moloney E.C., Brunner M., Alexander A.J., Clark J. Quantifying Fibrosis in Head and Neck Cancer Treatment: An Overview. *Head Neck.* 2015;37:1225-1231. doi: 10.1002/hed.23722.
12. Kraaijenga S.A.C., Oskam I.M., Van Der Molen L., Hamming-Vrieze O., Hilgers F.J.M., Van Den Brekel M.W.M. Evaluation of Long Term (10-Years+) Dysphagia and Trismus in Patients Treated with Concurrent Chemo-Radiotherapy for Advanced Head and Neck Cancer. *Oral Oncol.* 2015;51:787-794. doi: 10.1016/j.oraloncology.2015.05.003.
13. Galiano-Castillo N., Fernández-Lao C., Cantarero-Villanueva I., Fernández-De-Las-Peñas C., Menjón-Beltrán S., Arroyo-Morales M. Altered Pattern of Cervical Muscle Activation during Performance of a Functional Upper Limb Task in Breast Cancer Survivors. *Am. J.*

- Phys. Med. Rehabil. 2011;90:349-355. doi: 10.1097/PHM.0b013e318214e406.
14. Ringash J. Survivorship and Quality of Life in Head and Neck Cancer. *J. Clin. Oncol.* 2015;33:3322-3327. doi: 10.1200/JCO.2015.61.4115.
 15. Pidlyskij K., Roddam H., Rawlinson G., Selfe J. Exploring Aspects of Physiotherapy Care Valued by Breast Cancer Patients. *Physiother.* 2014;100:156-161. doi: 10.1016/j.physio.2014.03.006.
 16. Morishita S., Tsubaki A. Physical Therapy in Patients with Cancer. In: Suzuki T., editor. *Clinical Physical Therapy*. 1st ed. IntechOpen; London, United Kingdom: 2017.
 17. Bialosky J.E., Beneciuk J.M., Bishop M.D., Coronado R.A., Penza C.W., Simon C.B., George S.Z. Unraveling the Mechanisms of Manual Therapy: Modeling an Approach. *J. Orthop. Sports Phys. Ther.* 2018;48:8-18. doi: 10.2519/jospt.2018.7476.
 18. Pinheiro da Silva F., Moreira G.M., Zomkowski K., Amaral de Noronha M., Flores Sperandio F. Manual Therapy as Treatment for Chronic Musculoskeletal Pain in Female Breast Cancer Survivors: A Systematic Review and Meta-Analysis. *J. Manip. Physiol. Ther.* 2019;42:503-513. doi: 10.1016/j.jmpt.2018.12.007.
 19. Krisciunas G.P., Golan H., Marinko L.N., Pearson W., Jalisi S., Langmore S.E. A novel manual therapy programme during radiation therapy for head and neck cancer - our clinical experience with five patients. *Clin. Otolaryngol.* 2016;41:425-431. doi: 10.1111/coa.12535.
 20. Krisciunas G.P., Vakharia A., Lazarus C., Taborda S.G., Martino R., Hutcheson K., McCulloch T., Langmore S.E. Application of Manual Therapy for Dysphagia in Head and Neck Cancer Patients: A Preliminary National Survey of Treatment Trends and Adverse Events. *Glob. Adv. Health Med.* 2019;8:2164956119844151. doi: 10.1177/2164956119844151.
 21. Pilat A. *Myofascial Therapies: Myofascial Induction*. McGraw-Hill Interamericana; Madrid, Spain: 2003.
 22. Castro-Martín E., Ortiz-Comino L., Gallart-Aragón T., Esteban-Moreno B., Arroyo-Morales M., Galiano-Castillo N. Myofascial Induction Effects on Neck-Shoulder Pain in Breast Cancer Survivors: Randomized, Single-Blind, Placebo-Controlled Crossover Design. *Arch. Phys. Med. Rehabil.* 2017;98:832-840. doi: 10.1016/j.apmr.2016.11.019.
 23. Castro-Martín E., Galiano-Castillo N., Ortiz-Comino L., Cantarero-Villanueva I., Lozano-Lozano M., Arroyo-Morales M., Fernández-Lao C. Effects of a Single Myofascial Induction Session on Neural Mechanosensitivity in Breast Cancer Survivors: A Secondary Analysis of a Crossover Study. *J. Manip. Physiol. Ther.* 2020;43:394-404. doi: 10.1016/j.jmpt.2019.03.016.
 24. Serra-Añó P., Inglés M., Bou-Catalá C., Iraola-Lliso A., Espí-López G.V. Effectiveness of Myofascial Release after Breast Cancer Surgery in Women Undergoing Conservative Surgery and Radiotherapy: A Randomized Controlled Trial. *Support. Care Cancer.* 2019;27:2633-2641. doi: 10.1007/s00520-018-4544-z.
 25. Fourie W.J., Robb K.A. Physiotherapy Management of Axillary Web Syndrome Following Breast Cancer Treatment: Discussing the Use of Soft Tissue Techniques. *Physiotherapy.* 2009;95:314-320. doi: 10.1016/j.physio.2009.05.001.
 26. Chamorro Comesaña A., Suárez Vicente M.D.P., Docampo Ferreira T., Pérez-La Fuente

- Varela M.D.M., Porto Quintáns M.M., Pilat A. Effect of Myofascial Induction Therapy on Post-c-Section Scars, More than One and a Half Years Old. Pilot Study. *J. Bodyw. Mov. Ther.* 2017;21:197-204. doi: 10.1016/j.jbmt.2016.07.003.
27. Oliveira-Campelo N.M., Rubens-Rebelatto J., Martín-Vallejo F.J., Alburquerque-Sendín F., Fernández-De-Las-Peñas C. The Immediate Effects of Atlanto-Occipital Joint Manipulation and Suboccipital Muscle Inhibition Technique on Active Mouth Opening and Pressure Pain Sensitivity over Latent Myofascial Trigger Points in the Masticatory Muscles. *J. Orthop. Sports Phys. Ther.* 2010;40:310-317. doi: 10.2519/jospt.2010.3257.
28. Dwan K., Li T., Altman D.G., Elbourne D. CONSORT 2010 Statement: Extension to Randomised Crossover Trials. *BMJ.* 2019;366 doi: 10.1136/bmj.l4378. [PMC free article]
29. Patel S.G., Shah J.P. TNM Staging of Cancers of the Head and Neck: Striving for Uniformity Among Diversity. *CA Cancer J. Clin.* 2005;55:242-258. doi: 10.3322/canjclin.55.4.242.
30. Diagnóstico Pela Anamnese da Disfunção Craniomandibular–ScienceOpen. [(accessed on 5 May 2021)]. Available online: <https://www.scienceopen.com/document?vid=ca2c5ce5-8697-4e9b-85c9-88c70931a0da>
31. Su T.L., Chen A.N., Leong C.P., Huang Y.C., Chiang C.W., Chen I.H., Lee Y.Y. The Effect of Home-Based Program and Outpatient Physical Therapy in Patients with Head and Neck Cancer: A Randomized, Controlled Trial. *Oral Oncol.* 2017;74:130-134. doi: 10.1016/j.oraloncology.2017.10.002.
32. Audette I., Dumas J.P., Côté J.N., De Serres S.J. Validity and Between-Day Reliability of the Cervical Range of Motion (CROM) Device. *J. Orthop. Sports Phys. Ther.* 2010;40:318-323. doi: 10.2519/jospt.2010.3180.
33. Kolber M.J., Fuller C., Marshall J., Wright A., Hanney W.J. The Reliability and Concurrent Validity of Scapular Plane Shoulder Elevation Measurements Using a Digital Inclinator and Goniometer. *Physiother. Theory Pract.* 2012;28:161-168. doi: 10.3109/09593985.2011.574203.
34. Rauch A., Schierz O. Reliability of Mandibular Movement Assessments Depending on TMD. *Cranio-J. Craniomandib. Pract.* 2018;36:156-160. doi: 10.1080/08869634.2017.1325986.
35. Harris K.D., Heer D.M., Roy T.C., Santos D.M., Whitman J.M., Wainner R.S. Reliability of a Measurement of Neck Flexor Muscle Endurance. *Phys. Ther.* 2005;85:1349-1355. doi: 10.1093/ptj/85.12.1349.
36. Lee J.S., Hobden E., Stiell I.G., Wells G.A. Clinically Important Change in the Visual Analog Scale after Adequate Pain Control. *Acad. Emerg. Med.* 2003;10:1128-1130. doi: 10.1197/S1069-6563(03)00372-5.
37. Muir S.W., Corea C.L., Beaupre L. Evaluating Change in Clinical Status: Reliability and Measures of Agreement for the Assessment of Glenohumeral Range of Motion. *N. Am. J. Sports Phys. Ther.* 2010;5:98-110.
38. Lourenço A.S., Lameiras C., Silva A.G. Neck Flexor and Extensor Muscle Endurance in Subclinical Neck Pain: Intrarater Reliability, Standard Error of Measurement, Minimal Detectable Change, and Comparison With Asymptomatic Participants in a University Student Population. *J. Manipulative Physiol. Ther.* 2016;39:427-433. doi: 10.1016/j.jmpt.2016.05.005.

39. Pilat A. Myofascial Induction Therapy (MIT) In: Liem T., Tozzi P.C., editors. *Fascia in Osteopahty*. Handspring; Edinburgh, UK: 2017.
40. Boyd C., Crawford C., Paat C.F., Price A., Xenakis L., Zhang W., Buckenmaier C., Buckenmaier P., Cambron J., Deery C., et al. et al. The Impact of Massage Therapy on Function in Pain Populations—a Systematic Review and Meta-Analysis of Randomized Controlled Trials: Part II, Cancer Pain Populations. *Pain Med.* 2016;17:1553-1568. doi: 10.1093/pm/pnw100.
41. Li D.T.S., Leung Y.Y. Temporomandibular Disorders: Current Concepts and Controversies in Diagnosis and Management. *Diagnostics.* 2021;11:459. doi: 10.3390/diagnostics11030459. [PMC free article]
42. Loh S.Y., Mcleod R.W.J., Elhassan H.A. Trismus Following Different Treatment Modalities for Head and Neck Cancer: A Systematic Review of Subjective Measures. *Eur. Arch. Oto-Rhino-Laryngol.* 2017;274:2695-2707. doi: 10.1007/s00405-017-4519-6.
43. Kalamir A., Pollard H., Vitiello A., Bonello R. Intra-Oral Myofascial Therapy for Chronic Myogenous Temporomandibular Disorders: A Randomized, Controlled Pilot Study. *J. Man. Manip. Ther.* 2010;18:139-146. doi: 10.1179/106698110X12640740712374.
44. Zafar H., Nordh E., Eriksson P.O. Temporal Coordination between Mandibular and Head-Neck Movements during Jaw Opening-Closing Tasks in Man. *Arch. Oral Biol.* 2000;45:675-682. doi: 10.1016/S0003-9969(00)00032-7.
45. La Touche R., Fernández-De-Las-Peñas C., Fernández-Carnero J., Escalante K., Angulo-Díaz-Parreño S., Paris-Aleman A., Cleland J.A. The Effects of Manual Therapy and Exercise Directed at the Cervical Spine on Pain and Pressure Pain Sensitivity in Patients with Myofascial Temporomandibular Disorders. *J. Oral Rehabil.* 2009;36:644-652. doi: 10.1111/j.1365-2842.2009.01980.x.
46. Namvar H., Olyaei G., Moghadam B.A., Hosseinifar M. Effect of Myofascial Release Technique on Pain, Disability, Maximum Isometric Contraction of the Extensor Muscles, and Pressure Pain Threshold in Patients with Chronic Nonspecific Neck Pain: Double Blinded Randomized Clinical Trial. *Int. J. Med. Res. Heal. Sci.* 2016;5:500-506.
47. Gane E.M., McPhail S.M., Hatton A.L., Panizza B.J., O'Leary S.P. Neck and Shoulder Motor Function Following Neck Dissection: A Comparison with Healthy Control Subjects. *Otolaryngol.-Head Neck Surg.* 2019;160:1009-1018. doi: 10.1177/0194599818821885.

LIMITACIONES Y FORTALEZAS





Esta Tesis Doctoral presenta una serie de **limitaciones** que se han ido identificando a lo largo de los diferentes estudios expuestos, pero que es preciso resumir en este apartado. Esto permitirá considerar “los resultados” en este contexto.

La principal limitación de esta Tesis Doctoral radica en el diseño metodológico de las intervenciones propuestas. Se evaluó el efecto inmediato como el cambio producido tras la UM pero se tendría que buscar también una evaluación a medio o largo plazo. Dicha limitación será solventada en diseños futuros (véase apartado de Futuras Líneas de Investigación). De la misma manera, sería recomendable crear un programa de tratamiento con un número mayor de sesiones repartidas en el tiempo, porque en los estudios expuestos solo se aplicó una única sesión. Ha sido el punto de partida (efecto inmediato/una intervención/diseño cruzado) que permitirá el diseño de intervenciones más extensas y períodos de seguimiento más prolongados para dilucidar el mantenimiento o no de las mejoras encontradas en las secuelas de los pacientes oncológicos.

Otro aspecto común a los tres estudios fue que el fisioterapeuta que realizó la intervención siempre fue el mismo y que tenía una experiencia significativa con este tipo de procedimiento; si bien esto puede ofrecer ciertas ventajas en el ámbito de la investigación, debe tenerse en cuenta que diferentes profesionales pueden obtener resultados diferentes en el ámbito clínico. Otros estudios con más profesionales podrían arrojar luz sobre la idoneidad de UM en un entorno más similar a la práctica clínica habitual.

Por otro lado, el tamaño de muestra reducido pero adecuado, con un diseño cruzado utilizado en los tres estudios podría reducir las diferencias interindividuales de los participantes.

Finalmente, es posible que herramientas de evaluación diferentes y más sofisticadas conduzcan

a resultados diferentes o más específicos. Sin embargo, hasta donde sabemos, estos son los primeros trabajos en los que se evalúa los efectos de UM sobre las secuelas de supervivientes de CM y de CCC.

Como **fortalezas**, destacar que todos los cuestionarios y pruebas realizadas que se han utilizado eran validadas, lo que favorece la validez interna de los estudios.

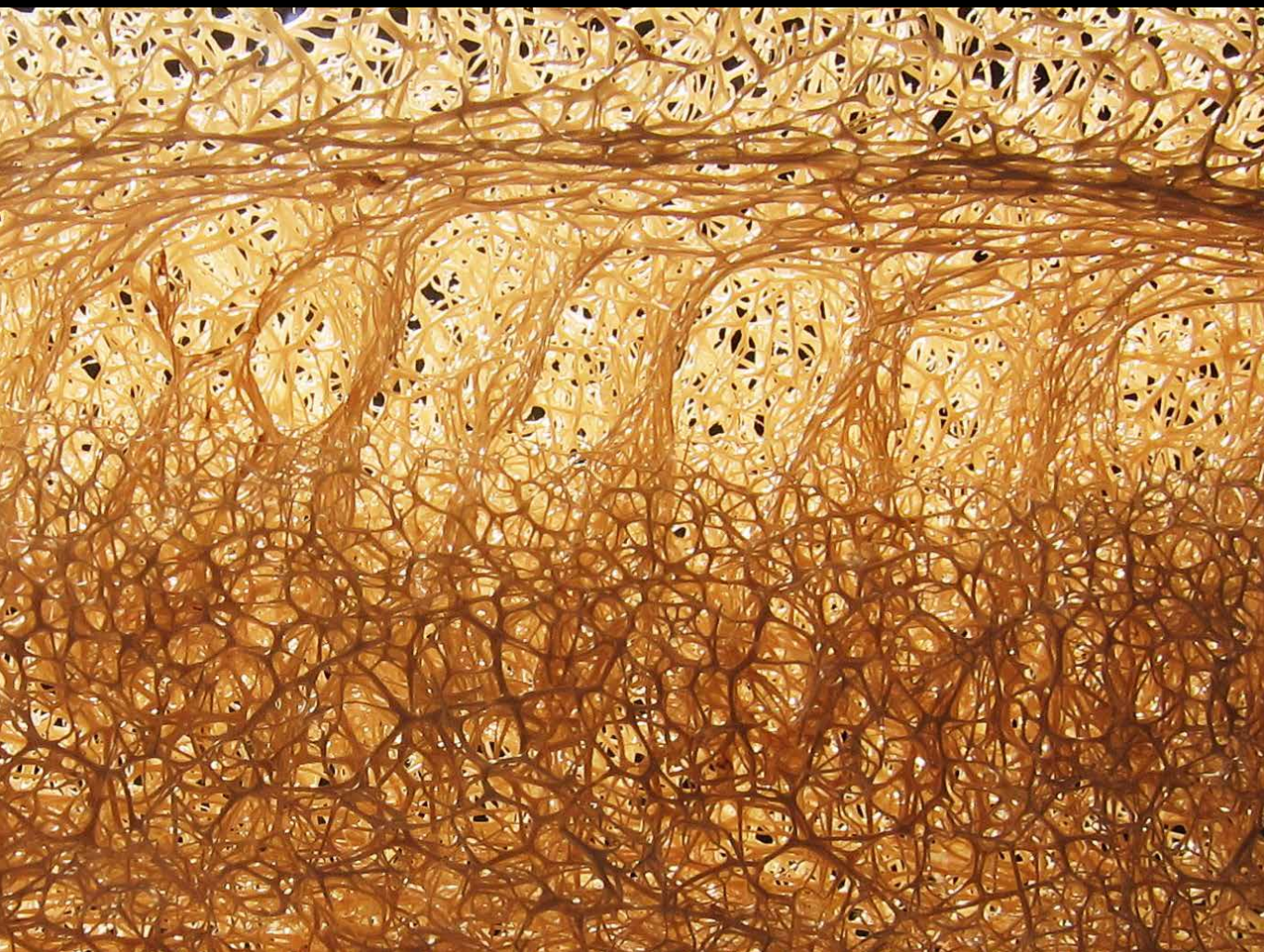
Esta Tesis Doctoral supone un trabajo novedoso, ya que presenta por primera vez tres estudios que investigan los efectos de un protocolo de IM (en concreto UM) en supervivientes oncológicos. Los resultados han mostrado cambios esperanzadores con los que mejorar la calidad de vida de este tipo de pacientes, sirviendo de ejemplo para futuros estudios con mayores tamaños de muestra.

A pesar de las limitaciones estadísticas de los tamaños de muestra de nuestros tres estudios, éstos fueron superiores a los calculados en un inicio, hecho que refuerza los resultados obtenidos.

Nuestro segundo estudio nos permitió encontrar un efecto de la IM independiente de las creencias que los pacientes tenían hacia el tratamiento. Esto refuerza la idea de que la IM genera cambios en el organismo además de la influencia que pueda tener el sistema de creencias del paciente.

Por otro lado, las conclusiones de esta Tesis Doctoral nos permiten seguir avanzando en la comprensión de la fisioterapia manual. El fisioterapeuta tiene en ella una herramienta fundamental que de manera aislada o mejor aún como parte de un tratamiento multimodal puede ser eficaz en el manejo de alguna de la sintomatología que sufren los supervivientes oncológicos.

FUTURAS LÍNEAS DE INVESTIGACIÓN

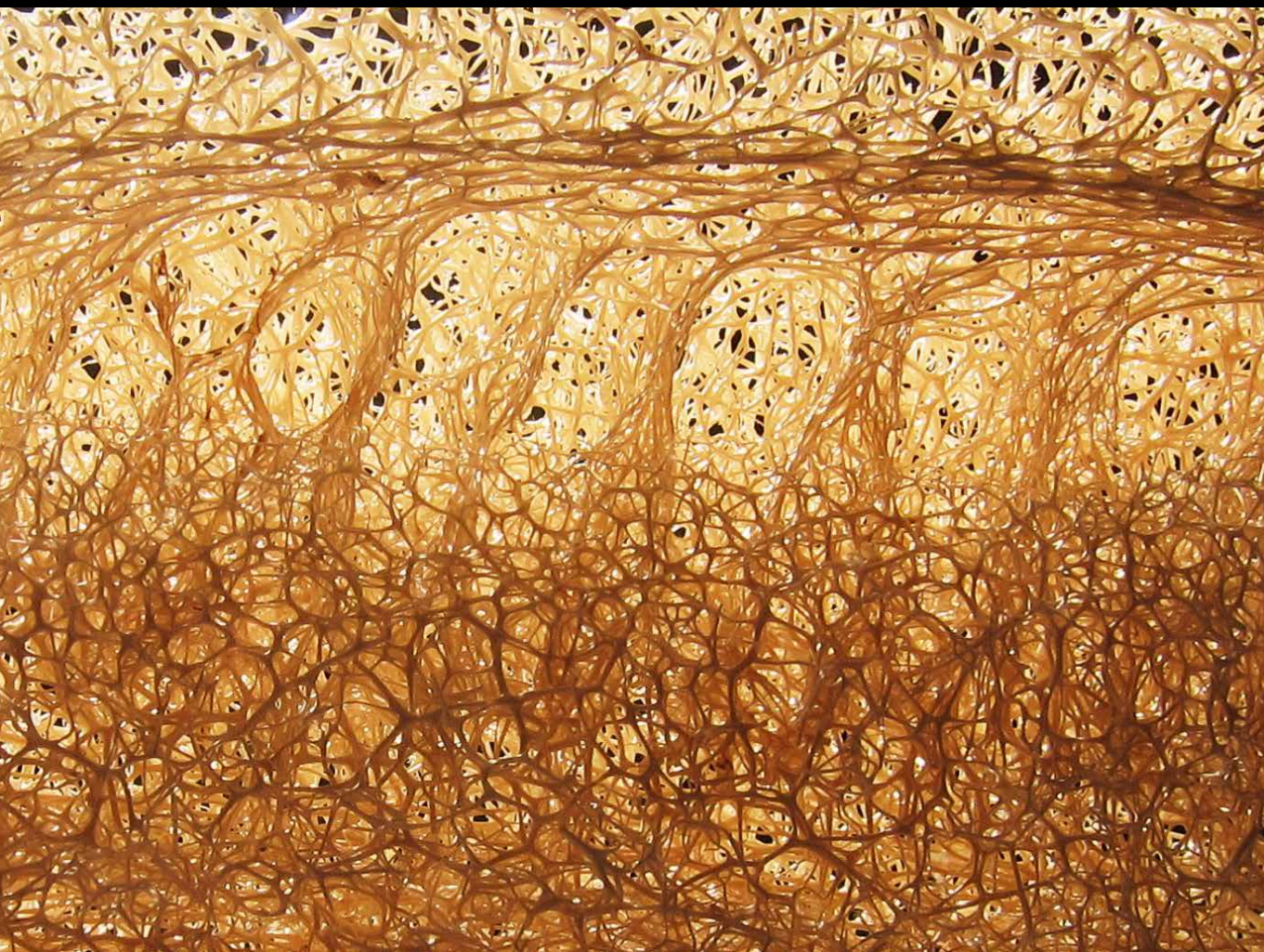




A partir de los resultados obtenidos en esta Tesis Doctoral, y reconociendo la todavía reducida evidencia científica sobre la IM y la inexistente sobre la UM, en poblaciones de supervivientes de cáncer y sus secuelas; se plantean diferentes líneas de investigación futuras sobre las que profundizar y trabajar:

- Utilizar un diseño metodológico con mayor número de sesiones y evaluaciones prolongadas en el tiempo, que permitan conocer la efectividad a medio y largo plazo.
- Trabajar con un tamaño muestral mayor para encontrar las diferencias interindividuales de los participantes.
- Intervenciones realizadas por diferentes fisioterapeutas darían mayor acercamiento al ámbito clínico.
- Sería interesante aplicar un placebo manual en el grupo control. Igualmente realizar estudios con un grupo de UM, un grupo con otro protocolo de tratamiento y otro grupo control (solo el tratamiento habitual médico).
- Es necesario que los futuros estudios aborden los factores predisponentes del dolor y las restricciones de la movilidad.
- Ahondar en la búsqueda de los efectos del tratamiento UM relacionados con el sistema autónomo a través de herramientas de valuación específicas para ello.
- A tenor de los resultados de esta tesis, desarrollar un programa de intervención sobre pacientes oncológicos en otras fases del proceso, como por ejemplo durante el tratamiento médico, buscando obtener no solo un efecto terapéutico sino también un efecto preventivo. Así lo muestran otros estudios con otro tipo de intervención manual.
- Del mismo modo, se plantea la posibilidad futura de aplicar la UM en otras poblaciones con diferentes procesos oncológicos.

CONCLUSIONES





CONCLUSIONES GENERALES

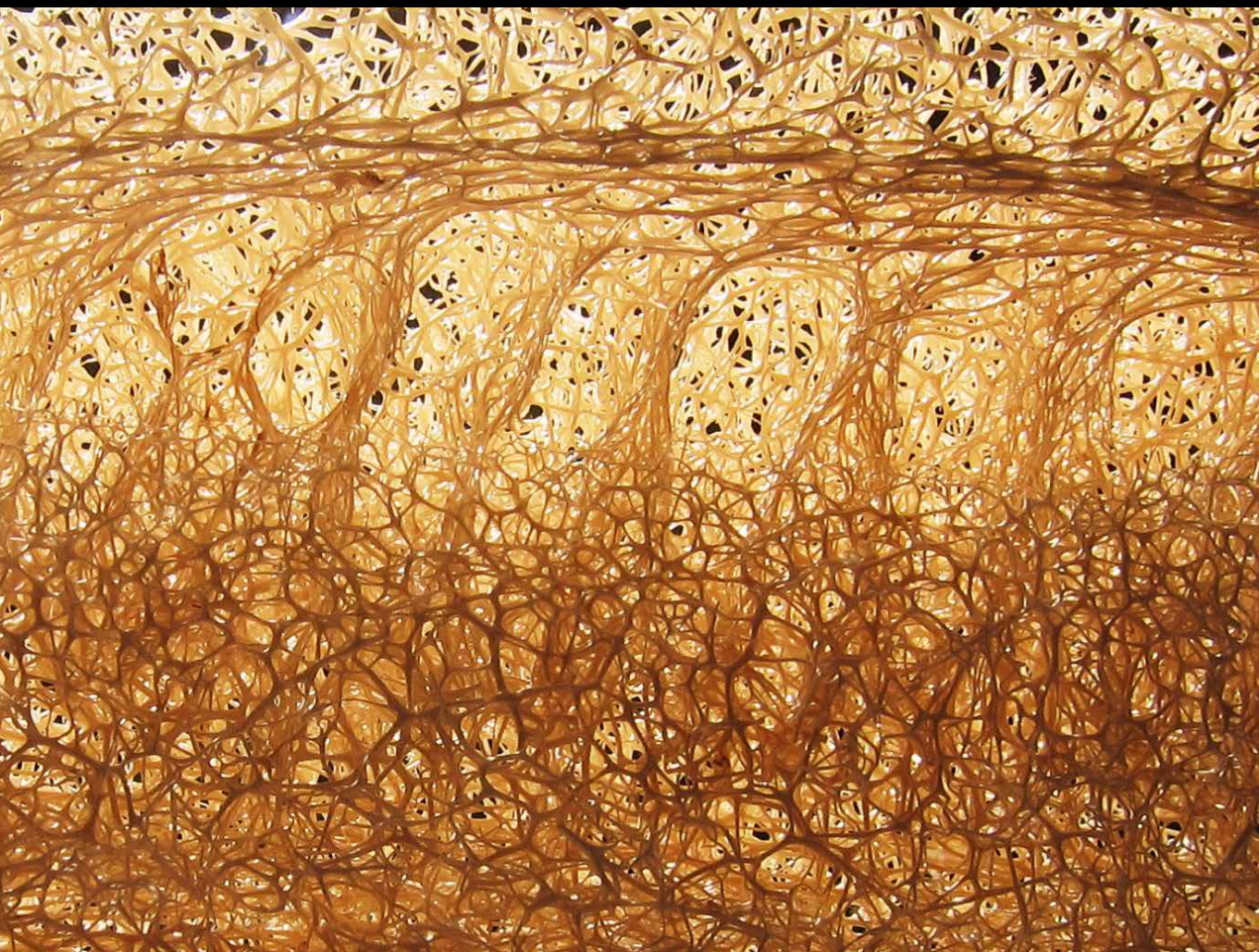
Esta Tesis Doctoral presenta un procedimiento terapéutico, IM, derivado de la TM y centrado en la intervención sobre el sistema fascial. IM se ha mostrado efectiva tanto clínica como estadísticamente, para mejorar las secuelas derivadas del tratamiento médico en los supervivientes de CM y CCC.

CONCLUSIONES ESPECÍFICAS

Las principales conclusiones de esta Tesis Doctoral son:

- Los supervivientes de CM y CCC presentan secuelas derivadas del proceso canceroso y del tratamiento médico. Nuestros pacientes mostraron dolor en la región cervical y hombro, disminución de la movilidad cervical y del hombro. Mecanosensibilidad de los principales nervios del miembro superior (supervivientes de CM). Restricción de la apertura bucal (supervivientes de CCC). Y debilidad de la musculatura flexora profunda cervical (supervivientes de CCC).
- IM se mostró efectiva para la mejora del dolor (cervical y hombro) y la movilidad (cervical y hombro) como secuelas derivadas de la patología cancerosa y el tratamiento médico en los supervivientes de CM y CCC.
- IM se mostró efectiva en la mejora de la mecano-sensibilidad de los tres nervios principales del miembro superior (mediano, radial y cubital) en supervivientes de CM.
- Nuestro estudio número dos mostró que el procedimiento terapéutico obtuvo beneficio de forma independiente a las actitudes del paciente hacia el tratamiento, sin la influencia de las experiencias previas del paciente.
- En nuestro tercer estudio se constató la mejoría de la función cervical a través del aumento de la resistencia de la musculatura flexora profunda de la región cervical en los supervivientes de CCC.
- IM se mostró eficaz para aumentar la apertura bucal en pacientes supervivientes de CCC con trismo.
- Nuestros tres estudios por primera vez, aportan la evidencia para justificar intervenciones a largo plazo con IM en poblaciones supervivientes de cáncer con el propósito de mejorar sus secuelas y recuperar su calidad de vida.

A N E X O S





ARTÍCULOS DERIVADOS DE LA TESIS DOCTORAL

A continuación, se enumeran y presentan (portada y última página) las publicaciones derivadas de esta Tesis Doctoral, ya incluidas en el manuscrito en la sección de material y métodos, resultados y discusión. De la misma manera, se muestran las publicaciones derivadas de la misma que se encuentran en fase de preparación/envío.

1. Castro-Martín, E., Ortiz-Comino, L., Gallart-Aragón, T., Esteban-Moreno, B., Arroyo-Morales, M., & Galiano-Castillo, N. (2017). Myofascial Induction Effects on Neck-Shoulder Pain in Breast Cancer Survivors: Randomized, Single-Blind, Placebo-Controlled Crossover Design. *Archives of physical medicine and rehabilitation*, 98(5), 832-840. <https://doi.org/10.1016/j.apmr.2016.11.019>
2. Castro-Martín, E., Galiano-Castillo, N., Ortiz-Comino, L., Cantarero-Villanueva, I., Lozano-Lozano, M., Arroyo-Morales, M., & Fernández-Lao, C. (2020). Effects of a Single Myofascial Induction Session on Neural Mechanosensitivity in Breast Cancer Survivors: A Secondary Analysis of a Crossover Study. *Journal of manipulative and physiological therapeutics*, 43(4), 394-404. <https://doi.org/10.1016/j.jmpt.2019.03.016>
3. Castro-Martín, E., Galiano-Castillo, N., Fernández-Lao, C., Ortiz-Comino, L., Postigo-Martin, P., & Arroyo-Morales, M. (2021). Myofascial Induction Therapy Improves the Sequelae of Medical Treatment in Head and Neck Cancer Survivors: A Single-Blind, Placebo-Controlled, Randomized Cross-Over Study. *Journal of clinical medicine*, 10(21), 5003. <https://doi.org/10.3390/jcm10215003>
4. Castro-Martín, E. et al. Trigeminal neuralgia in head and neck cancer survivors. An intervention with myofascial induction. En preparación.
5. Castro-Martín, E. et al. Fascia and movement. Understanding the mechanisms of fascial unwinding. En preparación.



ORIGINAL RESEARCH

Myofascial Induction Effects on Neck-Shoulder Pain in Breast Cancer Survivors: Randomized, Single-Blind, Placebo-Controlled Crossover Design



Eduardo Castro-Martín, MSc,^a Lucía Ortiz-Comino, MSc,^b Tania Gallart-Aragón, MSc,^c Bernabé Esteban-Moreno, PhD,^d Manuel Arroyo-Morales, PhD,^e Noelia Galiano-Castillo, PhD^f

From the ^aDepartment of Physical Therapy, Instituto Mixto Universitario Deporte y Salud (iMUDS), University of Granada, Granada; ^bCenter Medical Traffic SL, Granada; ^cUniversity Hospital Complex of Granada, Granada; ^dDepartment of Physical Therapy, University of Granada, Granada; ^eDepartment of Physical Therapy, Instituto Biosanitario Granada (IBS.Granada), Instituto Mixto Universitario Deporte y Salud (iMUDS), University of Granada, Granada; and ^fDepartment of Physical Therapy, Instituto Biosanitario Granada (IBS.Granada), University of Granada, Granada, Spain.

Abstract

Objectives: To (1) investigate the immediate effects of myofascial induction (MI), with placebo electrotherapy as a control, on perceived pain, cervical/shoulder range of motion (ROM), and mood state in breast cancer survivors (BCSs) with shoulder/arm morbidity; and (2) examine the relationships between pain modifications and cervical/shoulder ROM on the side affected by breast cancer.

Design: Randomized, single-blind, placebo-controlled crossover study.

Setting: Physical therapy laboratory.

Participants: BCSs (N=21) who had a diagnosis of stage I–IIIA breast cancer and had completed adjuvant therapy (except hormonal treatment).

Intervention: During each session, the BCSs received either an MI (fascial unwinding) intervention focused on the upper limb area following the Pilat approach or placebo pulsed shortwave therapy (control group). Each session lasted 30 minutes, and an adequate washout period of 4 weeks between sessions was established.

Main Outcome Measures: The visual analog scale (VAS) for pain and anxiety, shoulder-cervical goniometry for ROM, the Profile of Mood States for psychological distress, and the Attitudes Towards Massage Scale were used.

Results: An analysis of covariance (ANCOVA) revealed significant time $\times$ group interactions for VAS affected arm ($P=.031$) but not for VAS cervical ($P=.332$), VAS nonaffected arm ($P=.698$), or VAS anxiety ($P=.266$). The ANCOVA also revealed significant interactions for affected shoulder flexion ($P<.001$), abduction ($P<.001$), external rotation ($P=.004$), and internal rotation ($P=.001$). Significant interactions for affected cervical rotation ($P=.022$) and affected cervical lateral flexion ($P=.038$) were also found. A significant negative correlation was found between changes in VAS affected arm and shoulder/arm internal rotation ROM ($r=-.46$; $P=.03$).

Conclusions: A single MI session decreases pain intensity and improves neck-shoulder ROM to a greater degree than placebo electrotherapy for BCSs experiencing pain.

Archives of Physical Medicine and Rehabilitation 2017;98:832-40

© 2016 by the American Congress of Rehabilitation Medicine

Pain is a symptom experienced by 20% to 65% of breast cancer survivors (BCSs)^{1,2} as a result of surgical damage to sensory nerves³ or complications of radiotherapy⁴ or chemotherapy.⁵

Several factors are implicated in the onset of this problem, such as the presence of preoperative pain.⁶

Seven years after oncologic surgery, 40% to 70% of survivors have several range of motion (ROM) restrictions. Age and functioning 6 months after surgery are the best predictors of these ROM restrictions.⁷ These upper limb dysfunctions have a clear influence on quality of life⁸ and the ability to return to work⁹ among BCSs.

Supported by a research project grant (RS P10/02749-02764) from the Health Institute Carlos III and PN I+D+I 2008–2011 (FEDER funds); by a grant (Program FPU AP2010-6075) from the Education Ministry, Madrid, Spanish Government; and by the Andalusian Health Service, Junta de Andalucía (grant no. PI-0457-2010).

Clinical Trial Registration No.: NCT02859168.

Disclosures: none.

41. Andrade EM, Arce C, Seoane G. Adaptación al español del cuestionario 'Perfil de los Estados de Ánimo' en una muestra de deportistas. *Psicothema* 2002;14:708-13.
42. Fernández-Lao C, Cantarero-Villanueva I, Díaz-Rodríguez L, Fernández-de-las-Peñas C, Sánchez-Salado C, Arroyo-Morales M. The influence of patient attitude toward massage on pressure pain sensitivity and immune system after application of myofascial release in breast cancer survivors: a randomized, controlled crossover study. *J Manipulative Physiol Ther* 2012;35:94-100.
43. Moyer CA, Rounds J. The Attitudes Toward Massage (ATOM) Scale: reliability, validity, and associated findings. *J Bodyw Mov Ther* 2009;13:22-33.
44. Todd KH, Funk JP. The minimum clinically important difference in physician-assigned visual analog pain scores. *Acad Emerg Med* 1996;3:142-6.
45. Warpenburg MJ. Deep friction massage in treatment of radiation-induced fibrosis: rehabilitative care for breast cancer survivors. *Integr Med (Encinitas)* 2014;13:32-6.
46. Borstad JD, Szucs KA. Three-dimensional scapula kinematics and shoulder function examined before and after surgical treatment for breast cancer. *Hum Mov Sci* 2012;31:408-18.
47. Haddad CA, Saad M, Perez MdC, Miranda Júnior F. Assessment of posture and joint movements of the upper limbs of patients after mastectomy and lymphadenectomy. *Einstein (Sao Paulo)* 2013;11:426-34.
48. Johansen S, Fosså K, Nesvold IL, Malinen E, Fosså SD. Arm and shoulder morbidity following surgery and radiotherapy for breast cancer. *Acta Oncol* 2014;53:521-9.
49. Stubblefield MD, Keole N. Upper body pain and functional disorders in patients with breast cancer. *PM R* 2014;6:170-83.
50. Moyer CA, Rounds J, Hannum JW. A meta-analysis of massage therapy research. *Psychol Bull* 2004;130:3-18.
51. Ward RC. Integrated neuromusculoskeletal release and myofascial release. In: Ward RC, editor. *Foundations for osteopathic medicine*. 2nd ed. Philadelphia: Lippincott Williams and Wilkins; 2002.
52. Dorko BL. The analgesia of movement: ideomotor activity and manual care. *Int J Osteopath Med* 2003;6:93-5.
53. Schleip R. Fascial plasticity: a new neurobiological explanation. Part I. *J Bodyw Mov Ther* 2003;7:11-9.
54. Pilat A. Myofascial induction approaches. In: Fernández-de-las-Peñas C, Cleland JA, Dommerholt J, editors. *Manual therapy for musculoskeletal pain syndromes: an evidence- and clinical-informed approach*. 1st ed. London: Churchill Livingstone; 2016.
55. Caro-Morán E, Fernández-Lao C, Díaz-Rodríguez L, Cantarero-Villanueva I, Madeleine P, Arroyo-Morales M. Pressure pain sensitivity maps of the neck-shoulder region in breast cancer survivors. *Pain Med* 2016;17:1942-52.



Effects of a Single Myofascial Induction Session on Neural Mechanosensitivity in Breast Cancer Survivors: A Secondary Analysis of a Crossover Study

Eduardo Castro-Martín, PT, MSc,^{a, b} Noelia Galiano-Castillo, PT, PhD,^{a, b, c}
 Lucía Ortiz-Comino, PT, MSc,^a Irene Cantarero-Villanueva, PT, PhD,^{a, b, c}
 Mario Lozano-Lozano, OT, MSc,^{a, b, c} Manuel Arroyo-Morales, MD, PT, PhD,^{a, b, c} and
 Carolina Fernández-Lao, PT, PhD^{a, b, c}

ABSTRACT

Objectives: The purpose of this study was to investigate the short-term effects of myofascial induction on mechanosensitivity of upper limb nerves.

Methods: In this secondary analysis of a randomized, single-blind, placebo-controlled crossover study, 21 breast cancer survivors with stage I-IIIa cancer were randomly allocated to an experimental group (30 minutes of myofascial induction session) or placebo control group (unplugged pulsed 30 minutes of shortwave therapy), with a 4-week washout period between sessions that occurred in a physical therapy laboratory in the Health Science Faculty (University of Granada, Spain). Range of motion (universal goniometry), structural differentiation, symptoms (yes/no), and pressure pain thresholds (electronic algometry) were assessed during neurodynamic tests and attitude toward massage scale as covariate.

Results: An analysis of covariance revealed significant time $\times$ group interactions for range of motion in affected upper limb nerves (median, $P < .001$; radial, $P = .036$; ulnar, $P = .002$), but not for nonaffected upper limb nerves (median, $P = .083$; radial, $P = .072$; ulnar, $P = .796$). A χ^2 or Fisher exact test, as appropriate, also revealed a significant difference ($P = .044$) in sensitivity for the affected upper limb ulnar nerve in the experimental group, whereas the rest of the assessed nerves (affected and nonaffected upper limb nerves) showed no significant changes in either the experimental or control groups ($P > .05$). An analysis of covariance revealed no significant interactions on pressure pain thresholds over the nerves for affected (all $P > .05$) and nonaffected (all $P > .05$) upper limb nerves.

Conclusion: A single myofascial induction session may partially improve mechanosensitivity of median, radial, and ulnar nerves and yield positive effects on symptom mechanosensitivity, especially regarding the ulnar nerve in breast cancer survivors. (*J Manipulative Physiol Ther* 2020;43:394-404)

Key Indexing Terms: Breast Neoplasms; Musculoskeletal Manipulations; Range of Motion; Articular; Pain; Pain Threshold

INTRODUCTION

A recent study composed of three large cohorts reported that moderate to severe persistent pain occurred in 13.5%

to 20.3% of patients at 9 to 12 months after breast cancer (BC) surgery.¹ In addition, preoperative pain in the surgical area, high body mass index, axillary lymph node dissection, and more severe acute postoperative pain intensity at the seventh postoperative day were described as potential predictors of this troublesome adverse effect.¹

Currently, postmastectomy pain syndrome is widely accepted to refer to this painful condition,^{2,3} which consists of any pain persisting beyond the normal period of healing after medical treatment, with a neuropathic origin in the majority of cases.^{4,5} Moreover, this syndrome can be aggravated by adjuvant treatment,⁶ such as chemotherapy or radiotherapy. Velasco et al⁷ reinforce the idea of neurotoxic damage 1 month after finishing chemotherapy, emphasizing nerve growth factor as a biomarker of nerve damage, whereas radiotherapy causes both direct (axonal damage and demyelination) and indirect (compression by

^a Department of Physical Therapy, University of Granada, Granada, Spain.

^b Instituto Mixto Universitario Deporte y Salud, Granada, Spain.

^c Instituto Biosanitario Granada, Granada, Spain.

Corresponding author: Noelia Galiano-Castillo, PT, PhD, Department of Physical Therapy, Health Science Faculty, University of Granada, Avda de la Ilustración 60, 18016 Granada, Spain. (e-mail: noeliagaliano@ugr.es).

Paper submitted December 11, 2018; in revised form February 7, 2019; accepted March 29, 2019.

0161-4754

© 2020 by National University of Health Sciences.

<https://doi.org/10.1016/j.jmpt.2019.03.016>

- cervical whiplash: a randomised controlled trial. *Physiotherapy*. 2014;100(3):249-255.
44. Ingber DE. Tensegrity and mechanotransduction. *J Bodyw Mov Ther*. 2008;12(3):198-200.
 45. Kassolik K, Jaskólska A, Kisiel-Sajewicz K, Marusiak J, Kawczyński A, Jaskólski A. Tensegrity principle in massage demonstrated by electro- and mechanomyography. *J Bodyw Mov Ther*. 2009;13(2):164-170.
 46. Pilat A. Manual therapy for musculoskeletal pain syndromes of the upper and lower quadrants: an evidence and clinical informed approach. In: Fernández de las Peñas C, Cleland JA DJ, eds. *Manual Therapy for Musculoskeletal Pain Syndromes of the Upper and Lower Quadrants: An Evidence and Clinical Informed Approach*. London: Elsevier; 2015.
 47. Masi AT, Nair K, Evans T, Ghandour Y. Clinical, biomechanical, and physiological translational interpretations of human resting myofascial tone or tension. *Int J Ther Massage Bodywork*. 2010;3(4):16-28.
 48. Hromada J. On the nerve supply of the connective tissue of some peripheral nervous system components. *Acta Anat (Basel)*. 1963;55:343-351.
 49. Thomas POY. Peripheral neuropathy. In: Dyck P, Thomas P, Lambert E BR, eds. *Textbook of Peripheral Neuropathy*. 2nd ed Philadelphia: Saunders; 1984.
 50. Zusman M, Edwards B DA. Investigation of a proposed mechanism for the relief of spinal pain with passive joint movement. *J Man Med*. 1989;4:58-61.
 51. Wright A. Hypoalgesia post-manipulative therapy: a review of a potential neurophysiological mechanism. *Man Ther*. 1995;1(1):11-16.
 52. Pilat A. Myofascial induction therapy (MIT). In: Liem T, Tozzi P CA, eds. *Fascia in Osteopathy*. Edinburgh: Handspring; 2017.
 53. Bialosky JE, Bishop MD, Price DD, Robinson ME, George SZ. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. *Man Ther*. 2009;14(5):531-538.
 54. Bialosky JE, Beneciuk JM, Bishop MD, et al. Unraveling the mechanisms of manual therapy: modeling an approach. *J Orthop Sports Phys Ther*. 2018;48(1):8-18.
 55. Arroyo-Morales M, Olea N, Martínez MM, Hidalgo-Lozano A, Ruiz-Rodríguez C, Díaz-Rodríguez L. Psychophysiological effects of massage-myofascial release after exercise: a randomized sham-control study. *J Altern Complement Med*. 2008;14(10):1223-1229.
 56. Fernández-Pérez AM, Peralta-Ramírez MI, Pilat A, Villaverde C. Effects of myofascial induction techniques on physiologic and psychologic parameters: a randomized controlled trial. *J Altern Complement Med*. 2008;14(7):807-811.
 57. Heredia-Rizo AM, Oliva-Pascual-Vaca A, Rodríguez-Blanco C, Piña-Pozo F, Luque-Carrasco A, Herrera-Monge P. Immediate changes in masticatory mechanosensitivity, mouth opening, and head posture after myofascial techniques in pain-free healthy participants: a randomized controlled trial. *J Manipulative Physiol Ther*. 2013;36(5):310-318.



Article

Myofascial Induction Therapy Improves the Sequelae of Medical Treatment in Head and Neck Cancer Survivors: A Single-Blind, Placebo-Controlled, Randomized Cross-Over Study

Eduardo Castro-Martín ^{1,2,3,4}, Noelia Galiano-Castillo ^{1,2,3,4}, Carolina Fernández-Lao ^{1,2,3,4},
Lucía Ortiz-Comino ^{4,5}, Paula Postigo-Martín ^{1,2,3,4} and Manuel Arroyo-Morales ^{1,2,3,4}

¹ Department of Physical Therapy, Faculty of Health Sciences, University of Granada, 18016 Granada, Spain; eduardoc@ugr.es (E.C.-M.); noeliagaliano@ugr.es (N.G.-C.); paulapostigo@ugr.es (P.P.-M.); marroyo@ugr.es (M.A.-M.)

² Sport and Health University Research Institute (iMUDS), 18016 Granada, Spain

³ Instituto de Investigación Biosanitaria ibs. GRANADA, 18014 Granada, Spain

⁴ 'Cuidate' Support Unit for Oncology Patients, 18016 Granada, Spain

⁵ Department of Physical Therapy, Faculty of Health Sciences, Campus of Melilla, University of Granada, 52005 Melilla, Spain

* Correspondence: carolinafl@ugr.es (C.F.-L.); luciaoc@ugr.es (L.O.-C.)



Citation: Castro-Martín, E.; Galiano-Castillo, N.; Fernández-Lao, C.; Ortiz-Comino, L.; Postigo-Martín, P.; Arroyo-Morales, M. Myofascial Induction Therapy Improves the Sequelae of Medical Treatment in Head and Neck Cancer Survivors: A Single-Blind, Placebo-Controlled, Randomized Cross-Over Study. *J. Clin. Med.* **2021**, *10*, 5003. <https://doi.org/10.3390/jcm10215003>

Academic Editor: Alexandre Bozec

Received: 27 August 2021

Accepted: 25 October 2021

Published: 27 October 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract: Head and neck cancer (HNC) is the sixth most common cancer worldwide. Yet, less than 60% of HNC survivors receive adequate therapy for treatment-related sequelae. The objective of this study was to determine the efficacy of myofascial induction therapy (MIT) in improving cervical and shoulder pain and range of motion, maximal mouth opening, and cervical muscle function in HNC survivors. This crossover, blinded, placebo-controlled study involved 22 HNC survivors (average age 56.55 ± 12.71) of which 13 were males (59.1%) who received, in a crossover fashion, both a single 30-min session of MIT in the form of manual unwinding and simulated pulsed shortwave therapy (placebo), with a 4-week washout interval between the two. Cervical and shoulder pain (visual analogue scale) and range of motion (cervical range of motion device and goniometer), maximum mouth opening (digital caliper), and cervical muscle function (deep cervical flexor endurance test) were measured before and after the treatment and placebo sessions. A single session of MIT improved cervical and affected side shoulder pain, cervical range of motion, maximum mouth opening, and cervical muscle function. The associated effect sizes ranged from moderate to large. The present study suggests that MIT, in the form of manual unwinding, improves cervical (-3.91 ± 2.77) and affected-side shoulder (-3.64 ± 3.1) pain, cervical range of motion (flexion: 8.41 ± 8.26 deg; extension: 12.23 ± 6.55 ; affected-side rotation: 14.27 ± 11.05 ; unaffected-side rotation: 11.73 ± 8.65 ; affected-side lateroflexion: 7.95 ± 5.1 ; unaffected-side lateroflexion: 9.55 ± 6.6), maximum mouth opening (3.36 ± 3.4 mm), and cervical muscle function (8.09 ± 6.96 s) in HNC survivors.

Keywords: head and neck neoplasms; musculoskeletal manipulations; pain; range of motion

1. Introduction

Head and neck cancer (HNC) refers to any malignant tumor arising above the thoracic inlet and below the base of the skull. It therefore includes the oral cavity, pharynx, larynx, salivary glands and sinonasal cavities [1]. HNC is the sixth most common cancer worldwide; in 2019 more than 550,000 new cases were diagnosed. Its prevalence in men is twice that seen in women [2].

Tumor size, location and stage, guide the decision to treat via surgery and/or radiotherapy and chemotherapy; more advanced tumors commonly require combined treatments [3]. Surgical treatment involves tumor resection, plus neck dissection if the lymph nodes are affected. This procedure can leave sequelae such as pain and lack of mobility, leading to neck and shoulder dysfunction [4]. For its part, cumulative radiotherapy can generate

46. Namvar, H.; Olyaei, G.; Moghadam, B.A.; Hosseini, M. Effect of Myofascial Release Technique on Pain, Disability, Maximum Isometric Contraction of the Extensor Muscles, and Pressure Pain Threshold in Patients with Chronic Nonspecific Neck Pain: Double Blinded Randomized Clinical Trial. *Int. J. Med. Res. Heal. Sci.* **2016**, *5*, 500–506.
47. Gane, E.M.; McPhail, S.M.; Hatton, A.L.; Panizza, B.J.; O'Leary, S.P. Neck and Shoulder Motor Function Following Neck Dissection: A Comparison with Healthy Control Subjects. *Otolaryngol.-Head Neck Surg.* **2019**, *160*, 1009–1018. [[CrossRef](#)] [[PubMed](#)]



CURRICULUM VITAE CORTO

DATOS PERSONALES

Nombre y Apellidos: Eduardo Castro Martín

DNI: 34861027L

Nacionalidad: Española

Manuel Fecha inicio: 17/01/2010 Fecha fin: 17/01/2011 Cantidad (EUROS): 3000

FORMACIÓN UNIVERSITARIA

- Licenciado en Kinesiología y Fisiatría, Universidad Nacional General de San Martín, Buenos Aires, Argentina.
- Diplomado en Fisioterapia, Universidad de Granada, España.
- Master en Antropología Física y Forense. Universidad de Granada.
- Experto en Valoración del Daño Corporal. Universidad de Granada.
- Certificado de Aptitud Pedagógica (CAP), Universidad de Granada.

3. Nombre: INTEGRACIÓN DE LA IMAGEN ECOGRÁFICA PARA LA MEJORA DE LA ADQUISICIÓN DE COMPETENCIAS DE VALORACIÓN MUSCULOESQUELÉTICA. Código: 09-159 Ámbito: Autonómica Fecha inicio: 01/10/2009 Fecha fin: 01/10/2010 Cantidad (EUROS): 0

4. Nombre: INTERVENCIÓN PARA LA MEJORA DE LA CALIDAD DE VIDA RELACIONADA CON LA SALUD PARA ENFERMOS DE FIBROMIALGIA. Código: 00-0000 Ámbito: Autonómica Fecha inicio: 17/01/2009 Fecha fin: 16/01/2010 Cantidad (EUROS): 0

5. Nombre: INTERVENCIÓN PARA MEJORA DE LA CALIDAD DE VIDA RELACIONADA CON LA SALUD. Código: AGRAFIM-CTS 545 Ámbito: Autonómica Responsable: Delgado-Fernandez, Manuel Fecha inicio: 17/01/2008 Fecha fin: 16/01/2009 Cantidad (EUROS): 3000

PRODUCCIÓN Y ACTIVIDAD CIENTÍFICA

Libros

1. Título: REEDUCACIÓN SENSITIVA PERCEPTIVA-MOTRIZ | Editorial: ILUSTRE COLEGIO PROFESIONAL DE FISIOTERAPEUTAS DE ANDALUCÍA Año: 2005 ISBN: 84-609-4651-7 Autores: Catalán-Matamoras, Daniel Jesús; Castro-Martín, Eduardo

6. Nombre: EVALUACIÓN Y PROMOCIÓN DE CALIDAD DE VIDA RELACIONADA CON LA SALUD PARA ENFERMOS DE FIBROMIALGIA. Código: IAD-CTS 545 Ámbito: Autonómica Responsable: Delgado-Fernandez, Manuel Fecha inicio: 04/01/2008 Fecha fin: 04/01/2009 Cantidad (EUROS): 12000

Convenios y Contratos

2. Nombre: INTERVENCIÓN PARA MEJORA DE LA CALIDAD DE VIDA RELACIONADA CON LA SALUD. Código: SIN CÓDIGO Ámbito: Autonómica Responsable: Delgado-Fernandez,

Proyectos I+D+i y Ayudas

7. Proyecto: ABORDAJE DE LA SALUD ORAL Y LA CALIDAD DE VIDA EN SUPERVIVIENTES DE CÁNCER DE CABEZA Y CUELLO MEDIANTE TERAPIA DE FOTOBIMODULACIÓN COMPLEMENTADA CON UN SISTEMA DE M-HEALTH.

ESTUDIO L3AXER. Código: PI-0187-2021 Programa financiador: SUBVENCIONES EN RÉGIMEN DE CONCURRENCIA COMPETITIVA, PARA LA FINANCIACIÓN DE LA INVESTIGACIÓN, DESARROLLO E INNOVACIÓN (I+D+I) EN BIOMEDICINA Y EN CIENCIAS DE LA SALUD EN ANDALUCÍA, PARA EL AÑO 2021 Entidad financiadora: Conserjería de Salud y Familias. Junta de Andalucía. Responsable: Galiano-Castillo, Noelia Fecha inicio: 09/12/2021 Fecha fin: 08/12/2024

8. Proyecto: EFECTIVIDAD DE UN SISTEMA DE E-HEALTH INTEGRADO EN UN PROGRAMA DE RECUPERACIÓN FÍSICA PARA EL TRATAMIENTO DEL DOLOR EN LA POBLACIÓN ONCOLÓGICA. PaINEd STUDY. Código: PI-0171-2020 Ámbito del proyecto: Autonómica Programa financiador: Investigación, Desarrollo e Innovación (I+D+i) en Biomedicina y en Ciencias de la Salud en Andalucía Entidad financiadora: Consejería de Salud y Familias. Junta de Andalucía Fecha inicio: 01/01/2021 Fecha fin: 31/12/2023 Cuantía total (EUROS): 95.431,90 €

9. Proyecto: PROCURACIÓN DE JUSTICIA Y ACCESO A LA SALUD POR PARTE DE LA POBLACIÓN INDÍGENA EN MÉXICO: MEDIACIÓN INTERLINGÜÍSTICA E INTERCULTURAL. Código: PI21IX Ámbito del proyecto: Internacional no UE Programa financiador: OTROS PROGRAMAS, ORGANISMOS PÚBLICOS Responsable: Tercedor-Sánchez, María Isabel Fecha inicio: 31/12/2009 Fecha fin: 31/01/2012 Cuantía total (EUROS): 17500. Proyecto: MEJORA DE LA CALIDAD DE VIDA EN PERSONAS CON FIBROMIALGIA A TRAVÉS DE PROGRAMAS DE ACTIVIDAD FÍSICA Y MULTIDISCIPLINARES. Código: 1456 Ámbito del proyecto: Autonómica Programa financiador: PLAN PROPIO,

UNIVERSIDAD DE GRANADA Responsable: Delgado-Fernandez, Manuel Fecha inicio: 03/12/2008. Fecha fin: 03/12/2009 Cuantía total (EUROS): 4000

10. Proyecto: EVALUACIÓN Y PROMOCIÓN DE CALIDAD DE VIDA RELACIONADA CON LA SALUD PARA ENFERMOS DE FIBROMIALGIA. Código: 2994-00 Ámbito del proyecto: Autonómica Programa financiador: OTROS PROGRAMAS, JUNTA DE ANDALUCÍA Fecha inicio: 04/01/2008 Fecha fin: 04/01/2009 Cuantía total (EUROS): 10080

Algunas de las aportaciones a Congresos relacionadas con el objeto de la Tesis Doctoral

11. Título de la aportación: Alteraciones funcionales y dolor en pacientes de cáncer de cabeza y cuello: Afectación en el miembro superior. Nombre del congreso: II Congreso Nacional/ IV Jornadas de Jóvenes Investigadores en Formación fomentando la Interdisciplinariedad Tipo de evento: Poster en Congreso Ámbito: Nacional. Año: 26/06/2019 - 28/06/2019 Lugar: FACULTAD DE MEDICINA. UNIVERSIDAD DE GRANADA. Autores: Ortiz-Comino, Lucía; Martín-Martín, Lydia M^a; Paula Postigo-Martin; Lozano-Lozano, Mario; Castro-Martín, Eduardo; Fernández-Lao, Carolina
12. Título de la aportación: Presencia de dolor y disminución de la movilidad cervical en pacientes con cáncer de cabeza y cuello: estudio observacional. Nombre del congreso: Congreso Internacional de Fisioterapia de la Universidad Miguel Hernández Tipo de evento: Comunicación en congreso Ámbito: Internacional Año: 14/03/2019 - 16/03/2019 Lugar: Alicante Autores: Ortiz-Comino, Lucía; Laredo-expósito, María José; Castro-Martín, Eduardo.
13. Título de la aportación: Presencia de dolor y disminución de la movilidad cervical en

- pacientes con cáncer de cabeza y cuello: estudio observacional. Nombre del congreso: Congreso Internacional de Fisioterapia de la Universidad Miguel Hernández Tipo de evento: Comunicación en congreso Ámbito: Internacional Año: 14/03/2019 - 16/03/2019 Lugar: Alicante Autores: Ortiz-Comino, Lucía; Laredo-expósito, María José; Castro-Martín, Eduardo; Fernández-Lao, Carolina
14. Título de la aportación: presence of widespread pressure pain hypersensitivity and myofascial pain in head and neck cancer survivors. Nombre del congreso: Fifth International Fascia Research Congress Tipo de evento: Comunicación en congreso Ámbito: Internacional Año: 14/11/2018 - 15/11/2018 Lugar: Berlín, - Berlin, Alemania Autores: Ortiz-Comino, Lucía; Martín-Martín, Lydia M^a; Castro-Martín, Eduardo; Ruiz-vozmediano, Julia; Galiano-Castillo, Noelia; Arroyo-Morales, Manuel; Fernández-Lao, Carolina
 15. Título de la aportación: effects of myofascial induction on mobility and motor control in head and neck cancer survivors. A randomized, crossover, and single blind study. Nombre del congreso: Fifth International Fascia Research Congress Tipo de evento: Poster en Congreso Ámbito: Internacional Año: 14/11/2018 - 15/11/2018 Lugar: Berlín, - Berlin, alemania. Autores: Castro-Martín, Eduardo; Ortiz-Comino, Lucía; Román-ramos, María; Pilat, Andrejz; Lozano-Lozano, Mario; Cantarero-Villanueva, Irene; Fernández-Lao, Carolina
 16. Título de la aportación: efecto de una manobra profunda de liberación miofascial sobre el rango de movilidad de nervios periféricos en supervivientes de cáncer de mama: diseño cruzado. Nombre del congreso: v congreso internacional de investigación en salud y envejecimiento y iii congreso internacional de investigación en salud 2018 Tipo de evento: Comunicación en congreso Ámbito: Internacional Año: 28/06/2018 - 29/06/2018 Lugar: MURCIA Autores: Galiano-Castillo, Noelia; Lozano-Lozano, Mario; Castro-Martín, Eduardo; Fernández-Lao, Carolina.
 17. Título de la aportación: Presencia de fatiga y disminución de la condición física en supervivientes de cáncer de cabeza y cuello. Nombre del congreso: III Jornadas / I Congreso Nacional de Investigadores en Formación: fomentando la interdisciplinariedad (JIFFI). Tipo de evento: Comunicación en congreso Ámbito: Nacional Año: 20/06/2018 - 22/06/2018 Lugar: Granada, España Autores: Ortiz-Comino, Lucía; Martín-Martín, Lydia M^a; Castro-Martín, Eduardo; Ruiz-vozmediano, Julia ; Cruz-fernández, Mayra; Fernández-Lao, Carolina.
 18. Título de la aportación: inducción miofascial como tratamiento de la mecanosensibilidad neural en supervivientes de cáncer de mama. Nombre del congreso: II congreso internacional y vii encuentros hispano-cubanos en ciencias de la salud "salud y género" Tipo de evento: Poster en Congreso Ámbito: Internacional Año: 24/05/2018 - 26/05/2018 Lugar: CIENFUEGOS-CUBA Autores: Castro-Martín, Eduardo; Galiano-Castillo, Noelia; Ortiz-Comino, Lucía; Pilat, Andrzej; Achalandabaso-Ochoa, Alexander; Fernández-Lao, Carolina.
 19. Título de la aportación: Hipersensibilidad muscular y dolor de origen miofascial en supervivientes de cáncer de cabeza y cuello. Nombre del congreso: II Congreso Internacional y VII Encuentros Hispano-Cubanos en Ciencias de la Salud Tipo de evento: Poster en Congreso Ámbito: Internacional Año: 24/05/2018 - 26/05/2018 Lugar: Cienfuegos, Cuba Autores: Ortiz-Comino, Lucía; Martín-Martín, Lydia M^a; Castro-Martín, Eduardo; Galván -banqueri, Pilar ; Lozano-Lozano, Mario; Fernández-Lao, Carolina

20. Título de la aportación: Disfunción témporo-mandibular y dolor cervical en supervivientes de cáncer de cabeza y cuello. Nombre del congreso: II Congreso Internacional y VII encuentros Hispano-Cubanos en Ciencias de la Salud Tipo de evento: Poster en Congreso Ámbito: Internacional Año: 24/05/2018 - 26/05/2018 Lugar: Cienfuegos, Cuba Autores: Ortiz-Comino, Lucía; Cortés-díaz, Rosa; Cubillas-soto, Sandra ; Martín-Martín, Lydia M^a; Castro-Martín, Eduardo; Fernández-Lao, Carolina.

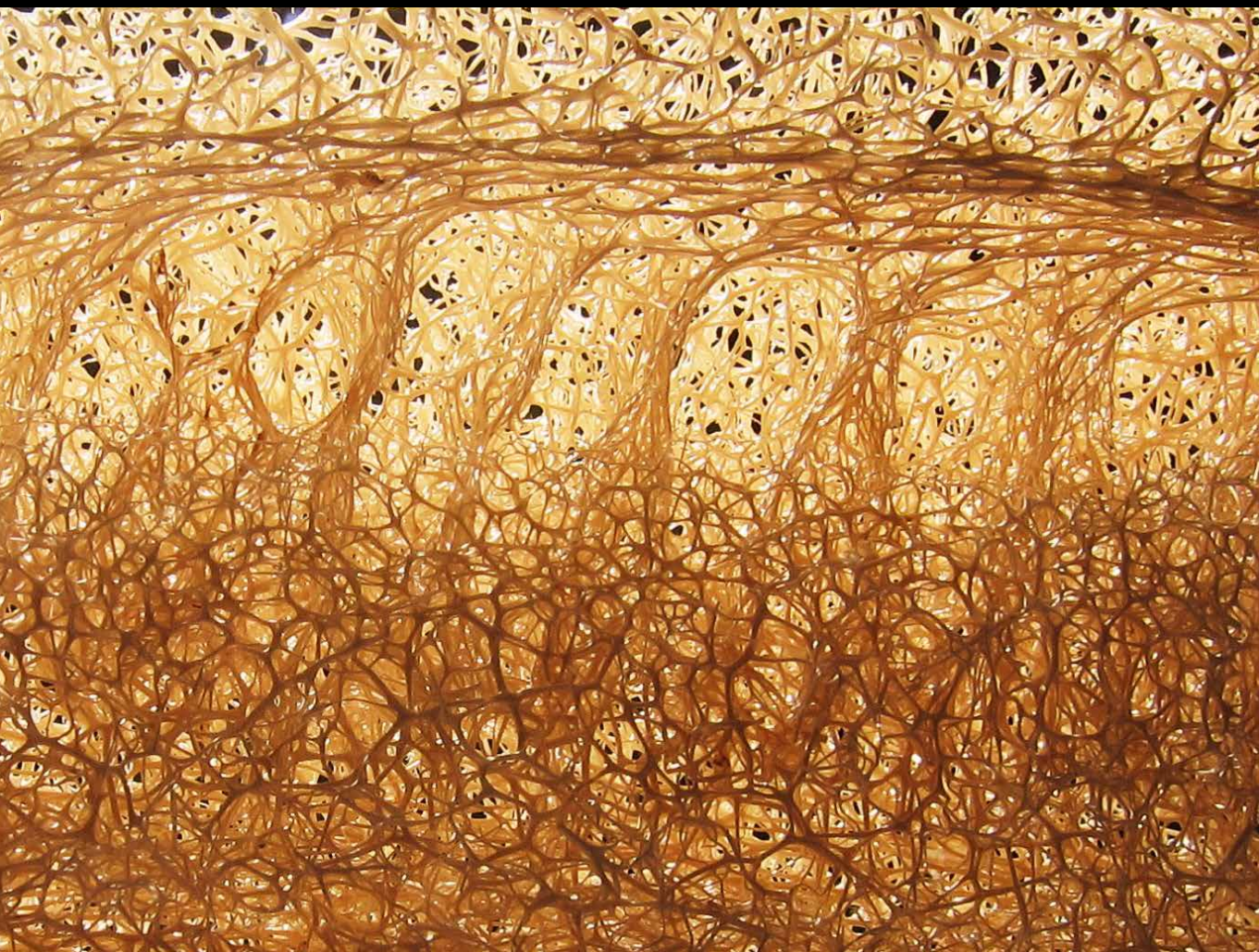
Publicaciones en Revistas

21. Postigo-Martin, P., Cantarero-Villanueva, I., Lista-Paz, A., Castro-Martín, E., Arroyo-Morales, M., & Seco-Calvo, J. (2021). A COVID-19 Rehabilitation Prospective Surveillance Model for Use by Physiotherapists. *Journal of clinical medicine*, 10(8), 1691. <https://doi.org/10.3390/jcm10081691>
22. Martin-Perez, A. J., Fernández-González, M., Postigo-Martin, P., Sampedro Pilegaard, M., Fernández-Lao, C., Castro-Martín, E., Martín-Martín, L., & Lozano-Lozano, M. (2021). Effectiveness of Analgesic Therapies in Patients with Vertebral Bone Metastasis: A Protocol for a Systematic Review and Meta-Analysis. *International journal of environmental research and public health*, 18(8), 3991. <https://doi.org/10.3390/ijerph18083991>
23. Martin-Perez, A. J., Fernández-González, M., Postigo-Martin, P., Sampedro Pilegaard, M., Fernández-Lao, C., Castro-Martín, E., Martín-Martín, L., & Lozano-Lozano, M. (2021). Effectiveness of Analgesic Therapies in Patients with Vertebral Bone Metastasis: A Protocol for a Systematic Review and Meta-Analysis. *International journal of environmental research and public health*, 18(8), 3991. <https://doi.org/10.3390/ijerph18083991>
24. Castro-Martín, E., Galiano-Castillo, N., Fernández-Lao, C., Ortiz-Comino, L., Postigo-Martin, P., & Arroyo-Morales, M. (2021). Myofascial Induction Therapy Improves the Sequelae of Medical Treatment in Head and Neck Cancer Survivors: A Single-Blind, Placebo-Controlled, Randomized Cross-Over Study. *Journal of clinical medicine*, 10(21), 5003. <https://doi.org/10.3390/jcm10215003>
25. Castro-Martín, E., Galiano-Castillo, N., Ortiz-Comino, L., Cantarero-Villanueva, I., Lozano-Lozano, M., Arroyo-Morales, M., & Fernández-Lao, C. (2020). Effects of a Single Myofascial Induction Session on Neural Mechanosensitivity in Breast Cancer Survivors: A Secondary Analysis of a Crossover Study. *Journal of manipulative and physiological therapeutics*, 43(4), 394–404. <https://doi.org/10.1016/j.jmpt.2019.03.016>
26. Ortiz-Comino, L., Fernández-Lao, C., Castro-Martín, E., Lozano-Lozano, M., Cantarero-Villanueva, I., Arroyo-Morales, M., & Martín-Martín, L. (2020). Myofascial pain, widespread pressure hypersensitivity, and hyperalgesia in the face, neck, and shoulder regions, in survivors of head and neck cancer. *Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer*, 28(6), 2891–2898. <https://doi.org/10.1007/s00520-019-05173-6>
27. Castro-Martín, E., Ortiz-Comino, L., Gallart-Aragón, T., Esteban-Moreno, B., Arroyo-Morales, M., & Galiano-Castillo, N. (2017). Myofascial Induction Effects on Neck-Shoulder Pain in Breast Cancer Survivors: Randomized, Single-Blind, Placebo-Controlled Crossover Design. *Archives of physical medicine and rehabilitation*, 98(5), 832–840. <https://doi.org/10.1016/j.apmr.2016.11.019>
28. Gallart-Aragón, T., Fernández-Lao, C., Castro-Martín, E., Cantarero-Villanueva, I., Cózar-Ibáñez, A., & Arroyo-Morales, M. (2017). Health-Related Fitness Improvements in Morbid Obese Patients After Laparoscopic

- Sleeve Gastrectomy: a Cohort Study. *Obesity surgery*, 27(5), 1182–1188. <https://doi.org/10.1007/s11695-016-2427-2>
29. Valenza, M. C., Castro-Martín, E., Valenza, G., Guirao-Piñeiro, M., De-la-Llave-Rincón, A. I., & Fernández-de-las-Peñas, C. (2012). Comparison of third-year medical and physical therapy students' knowledge of anatomy using the carpal bone test. *Journal of manipulative and physiological therapeutics*, 35(2), 121–126. <https://doi.org/10.1016/j.jmpt.2011.12.005>
 30. Arroyo-Morales, M., Cantarero-Villanueva, I., Fernández-Lao, C., Guirao-Piñeyro, M., Castro-Martín, E., & Díaz-Rodríguez, L. (2012). A blended learning approach to palpation and ultrasound imaging skills through supplementation of traditional classroom teaching with an e-learning package. *Manual therapy*, 17(5), 474–478. <https://doi.org/10.1016/j.math.2012.04.002>
 31. Cantarero-Villanueva, I., Fernández-Lao, C., Galiano-Castillo, N., Castro-Martín, E., Díaz-Rodríguez, L., & Arroyo-Morales, M. (2012). Evaluation of e-learning as an adjunctive method for the acquisition of skills in bony landmark palpation and muscular ultrasound examination in the lumbopelvic region: a controlled study. *Journal of manipulative and physiological therapeutics*, 35(9), 727–734. <https://doi.org/10.1016/j.jmpt.2012.10.007>
 32. Gatto-Cardia, María Claudia; Baena-Beato, Pedro Angel; Castro-Martín, Eduardo; Soto-Hermoso, Victor Manuel; Robles-Fuentes, Alejandro; Dafos-Garaizábal, Francisco Javier; Latorre-Román, Pedro Angel; Heredia-jimenez, Jose; Aguayo-Muela, Álvaro. (2009). Evaluación postural estática utilizando un novedoso método fotogramétrico. *Gaceta Sanitaria*.
 33. Castro-Martín, Eduardo; Tercedor, Pablo. (2000). Bioscopic anatomy: a teaching idea for physiotherapy. *European Journal of Anatomy*.
 34. Castro-Martín, Eduardo; Tercedor, Pablo. (2000). Practical anatomy: a teaching approach in physiotherapy. *European Journal of Anatomy*.
- ### Capítulos de Libros
35. Craniofacial and neck dysfunctions related to the fascial system. Castro-Martín, Eduardo; Pilat, Andrzej. *Myofascial Induction. An anatomical approach to the treatment of fascial dysfunction Volume 1: The Upper Body*. Edimburgo. Handspring. 2022.
 36. Myofascial Induction Therapy. Castro-Martín, Eduardo; Pilat, Andrzej. *Myofascial Induction. An anatomical approach to the treatment of fascial dysfunction Volume 1: The Upper Body*. Edimburgo. Handspring. 2022.
 37. Movement and force transmission in the fascial system. Castro-Martín, Eduardo; Pilat, Andrzej. *Myofascial Induction. An anatomical approach to the treatment of fascial dysfunction Volume 1: The Upper Body*. Edimburgo. Handspring. 2022.
 38. Upper quadrant assessment. Castro-Martín, Eduardo; Pilat, Andrzej. *Myofascial Induction. An anatomical approach to the treatment of fascial dysfunction Volume 1: The Upper Body*. Edimburgo. Handspring. 2022.
 39. Efecto de la terapia ocupacional en las alteraciones del miembro superior de supervivientes de cancer de mama: estudio preliminar. Lozano-Lozano, Mario; Galiano-Castillo, Noelia; Castro-Martín, Eduardo. *Avances en la investigación en salud. Volumen III*. Almería. Asunivep. 2018.
 40. Efecto de una maniobra profunda de liberación miofascial sobre el rango de movilidad de nervios periféricos en supervivientes de cancer de mama: diseño cruzado. Galiano-Castillo, Noelia; Lozano-Lozano, Mario;

- Castro-Martín, Eduardo. Avances en la investigación en salud. Volumen IV. Almería. Asunivep. 2018.
41. Myofascial induction approaches in temporomandibular disorders. Castro-Martín, Eduardo. In Temporomandibular Disorders Manual therapy, exercise, and meedling. Edimburgo. Handspring. 2018.
 42. ECOFISIO.COM: e-learning aplicado a la adquisición de habilidades en palpación y ecografía musculoesqueletica para fisioterapeutas. Cantarero-Villanueva, Irene; Fernández-Lao, Carolina; Díaz-Rodríguez, C.Lourdes; Castro-Martín, Eduardo; Guirao-Piñeyro, Miguel; Esteban-Moreno, Bernabe; Arroyo-Morales, Manuel. Innovación Docente y Buenas Prácticas en la Universidad de Granada (Volumen III). Universidad de Granada. 2012.
 43. Neuroanatomía básica aplicada. Guirao-Piñeyro, Miguel; Pascual-Morenilla, Maria Teresa; Lopez-Soler, Miguel; Castro-Martín, Eduardo. Tumores del snc en el adulto y en la infancia. Grupo Aula Médica S.L. 2012.
 44. Una propuesta elearning ecofisio.com para adquisicion de habilidades en el proceso de evaluacion de la lumbalgia: estudio randomizado controlado. Cantarero-Villanueva, Irene; Fernández-Lao, Carolina; Díaz-Rodríguez, C.Lourdes; Galiano-Castillo, Noelia; Castro-Martín, Eduardo; Arroyo-Morales, Manuel. FECIES 2012. Asociacion española de psicologia conductual. 2012.
 45. Percepción del alumnado en torno al uso de las TICS para el desarrollo de competencias Percepción del alumnado en torno al uso de las TICs para el desarrollo de competencias en valoración del aparato locomotor. Cantarero-Villanueva, Irene; Fernández-Lao, Carolina; Díaz-Rodríguez, C.Lourdes; Castro-Martín, Eduardo; Esteban-Moreno, Bernabe; Arroyo-Morales, Manuel. VIII Foro de Evaluación de la Calidad de la Investigación y de la Educación. 2011.
 46. Metodología multidisciplinar para el análisis de la salud, calidad de vida y predicción de la dependencia de personas adultas y mayores desde la perspectiva de la motricidad. Soto-Hermoso, Victor Manuel; Delgado-Fernandez, Manuel; Tercedor, Pablo; Castro-Martín, Eduardo; Aparicio, Virginia A.; Heredia-jimenez, Jose; Baena-Beato, Pedro Angel; Gatto-Cardia, María Claudia; Martínez-Morales, José Manuel. Educación física y ciencias afines: alternativas de integración y salud para el hombre y la mujer del siglo XXI. Córdoba. Universidad de Huelva Publicaciones. 2008.
 47. Protocolo de evaluación integral de la condición física y salud de los socorristas. Soto-Hermoso, Victor Manuel; Tercedor, Pablo; Castro-Martín, Eduardo; Heredia-jimenez, Jose; Baena-Beato, Pedro Angel; Gatto-Cardia, María Claudia; Martínez-Morales, José Manuel; Delgado-Fernandez, Manuel. Congreso internacional de salvamento y socorismo. La Coruña. 2007.
 48. Fisioterapia en los síndromes de la travesía torácica. Castro-Martín, Eduardo. Curso de formación continuada para fisioterapeutas. Ilustre Colegio Profesional de Fisioterapia de Andalucía. 2005.

A G R A D E C I M I E N T O S





Sinceramente nunca visualicé este momento. Encaré mi profesión ayudando en la recuperación funcional de personas que sufrían dolor y alteraciones del movimiento. En otras ocasiones, las tareas docentes captaban mi atención teniendo la suerte de poder desarrollarlas en mi ámbito profesional. Pero el rol investigador nunca estuvo presente en mi imaginario. De hecho, mi interés en este campo era escaso o nulo, y tristemente nunca entendía porqué debía cambiar mi perspectiva. Es cierto que crecí profesionalmente en un espacio temporal carente de investigación en el que la prioridad era afianzar el desarrollo clínico de la profesión, pero ¿cómo hacerlo sin plantearse lo qué hacemos?.

Hace muchos años que conozco a **Manuel Arroyo Morales**, compañero de profesión y de Departamento. Él, con gran precocidad sí entendió la relevancia de investigar y con su espíritu crítico (de los más elevados que he encontrado) apostó por esta vía. El resultado de su interés, en mi opinión, es un enorme avance en las bases de nuestra profesión. Sus tareas investigadoras han permitido que la fisioterapia se asiente en conocimientos contrastados que ahora operan desde la evidencia. Es admirable lo que has hecho por la fisioterapia. Junto a él, la profesora **Noelia Galiano Castillo**, ella no tuvo que descubrir la importancia de investigar porque ella nació (profesionalmente) con el ADN investigador, comprendiendo que esta es la vía para que cualquier parcela del conocimiento (también la fisioterapia) progrese y se afiance. Trabajadora, audaz e incansable, todavía me sorprende (y la conozco desde hace mucho) su enorme facilidad para resolver dificultades, ¿sabes lo mucho que ayudas? y, ¿la gran persona que eres? Noelia y Manuel sois fuente de inspiración para muchos. Y qué honor, aceptasteis ser mis directores, y al hacerlo lograsteis un milagro, ¿cómo habéis conseguido que un no creyente como yo se convirtiera en un interesado en la investigación? Lo hicisteis como grandes investigadores, lo lograsteis con paciencia. Creo que solo así, dedicándome “años” podíais conseguirlo. Sois los responsables de que pueda vivir una nueva etapa en mi profesión, a mis años, es emocionante y gratificante. Gracias Manuel y Noelia por hacerlo posible, por ser pacientes y creer antes que yo. Sois enormes.

A los **pacientes**, otro pilar de este trabajo. Desgraciadamente ellos sufren y mucho, son una lección de vida y se merecen todo nuestro esfuerzo y atención, ellos son el motivo por el que somos fisioterapeutas clínicos y también por el que investigamos. Gracias a vosotros esta Tesis existe.

Una compañera fundamental en este camino ha sido la profesora **Fernández Lao. Carolina** es pura generosidad y una fuente de conocimiento inagotable. Sus recomendaciones han sido una guía constante para mí, ojalá colaboremos por siempre. Gracias Carolina tu presencia es imprescindible.

Otra pieza clave de esta Tesis Doctoral fue **Lucía Ortiz Comino**, mi compañera incansable en las tareas investigadoras, con ella he recorrido este camino desde el principio y con ella espero seguir. Me motivas, me educas y me aportas constantemente, qué suerte haberte conocido. Gracias Lucía esta Tesis también es tuya.

En realidad he tenido mucha suerte, siempre he recibido la mano tendida de todo el grupo Cúdate y Bio 277, doy las gracias a todos sus integrantes. Sin olvidar a nadie quisiera nombrar a **Concepción Ruiz Rodríguez**, gracias por aceptarme, tenéis una calidad enorme, ojalá pueda yo estar a la altura y contribuir. También a **Mario Lozano Lozano**, has sido todo un descubrimiento, es asombroso lo que aportas, aprendo mucho de ti, sinceramente gracias. Y a **Irene Cantarero Villanueva**, porque siempre estás, en ocasiones en la sombra, pero siempre estás, y cuando tenemos una conversación es desde la verdad. Gracias por tu verdad, me ayudas mucho.

Otro regalo lo recibo constantemente de mis compañeras y compañeros de Departamento. Gracias a todos, siento vuestro cariño y apoyo, me reconforta. Agradezco a **Irene Cabrera Martos** y a **Ángela Benítez Feliponi** su presencia desde hace muchos años como incansables compañeras de asignaturas, aunque no lo sepáis vosotras también me habéis ayudado en esta Tesis. A **M^a Carmen García Ríos** y a **Antonio Manuel Fernández Pérez** también quiero agradecerles sus constantes muestras de apoyo, la fuerza que me transmitáis y el sincero interés para que realizase este trabajo. Sois grandes personas, me habéis empujado mucho, gracias. Y a **Carmen**, tú y yo comenzamos académicamente juntos y ha sido un honor ver tu evolución, admiro tu capacidad, tu entrega y tu valentía, y siempre te siento cerca aunque estemos en “ligas” diferentes (la tuya de champions). Gracias compañera por no separarte y no dejar de apoyarme, eres muy importante para mí.

En la distancia pero muy próximo a la vez, visualizo a mi amigo **Patxi**, un corazón andante que no guarda nada para después. Gracias también por tu continuo ofrecimiento y tu infinita generosidad.

Hoy recuerdo también a mis “Maestros”. Me refiero a las personas que me han educado y guiado a lo largo de mi aventura profesional/personal. Pri-

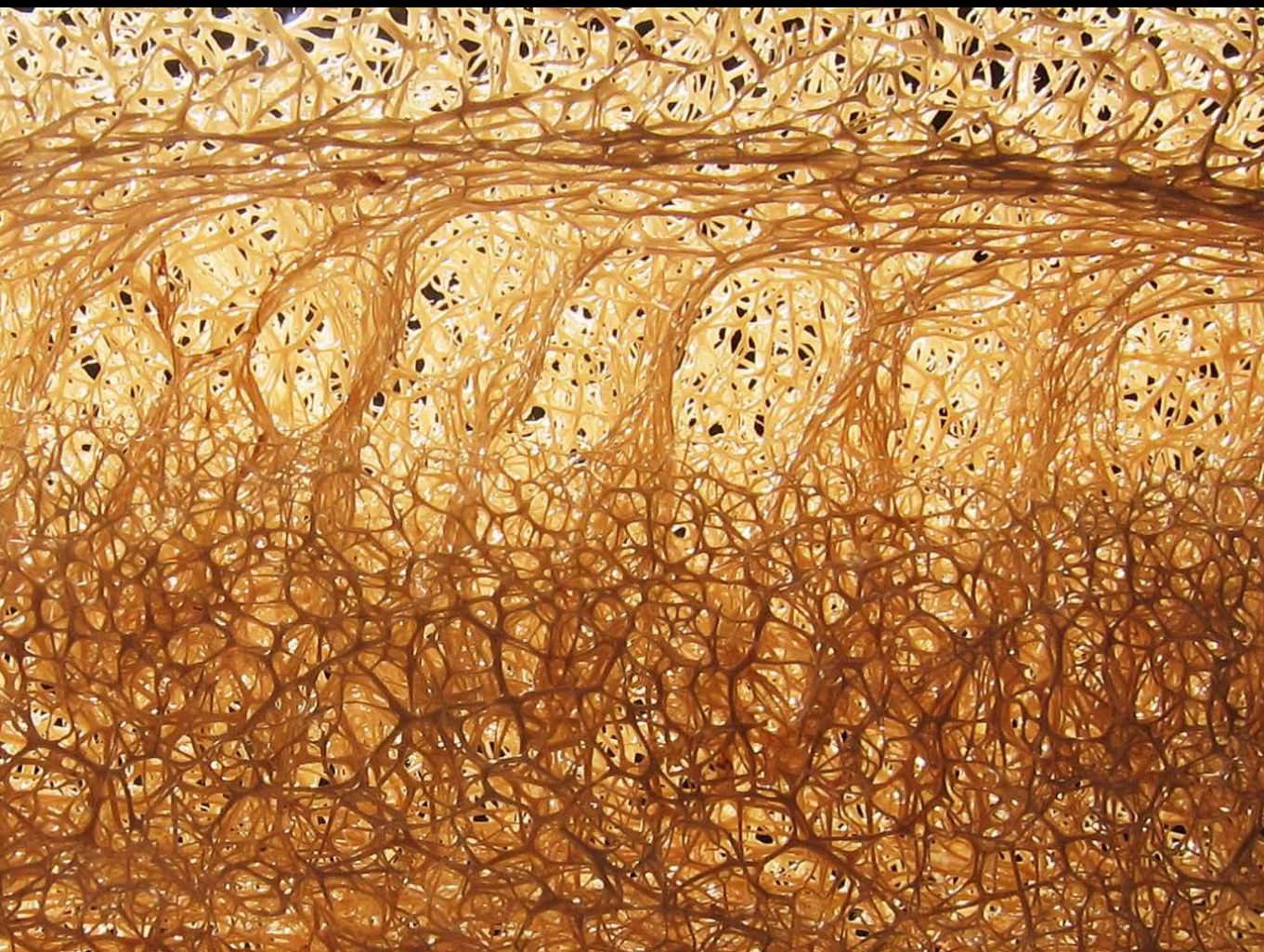
mero a la persona que me descubrió la Fisioterapia y logró que me apasionase con la profesión, eres un ejemplo para todos y siempre recuerdo tus consejos, gracias **Gerald**. Segundo, a quien inyectó su amor por la docencia en mis venas y generó en mí todo lo que hoy docentemente pueda ser, gracias **Miguel**, mi “padre” académico. Y tercero, el gran fisioterapeuta que me educó en el universo fascial y que hoy representa un modelo que me gustaría perseguir, ojalá pueda acercarme, gracias **Andrzej**. Qué afortunado me siento al tener tantos maestros/amigos.

Y me acuerdo de mis **alumnos**, con los que comparto lo poco que pueda saber y de los que tanto recibo, es mucho lo que me enseñáis, gracias por ser pacientes conmigo.

Por último, mi familia, sois lo más importante. Mi **padre** que estará disfrutando de este trabajo desde las alturas, donde yo siempre le he visto, admiro tu sensibilidad, eres una gran persona. Mi **madre** con la que tengo la suerte de compartir mi vida y de la que tanto aprendo y de la que tanto recibo, amor y apoyo incondicional. **Lucía, Clara e Ignacio**, mis hijos y mi compañera hasta el infinito **Inma**, vosotros sois mi núcleo duro, el que me inspira, el que le da sentido a mi vida y el que me ha dotado de fuerza y tiempo para realizar esta Tesis, casi nada, fuerza y tiempo... y lo habéis hecho desde el amor, ojalá yo esté a vuestra altura. Os quiero mucho. Mil gracias familia.

En una de esas conversaciones verdaderas con Irene, ella me dijo sobre su Tesis “...cuanto lloré escribiendo los agradecimientos...”, es cierto, se llora mucho, con emoción, con alegría, por que me hago consciente de la gran suerte que tengo, por estar rodeado de tanto calor, sincero y espontáneo. Una vida sin amor no es vida y yo recibo mucho... qué afortunado me siento. Gracias.

NOTAS





Handwriting practice lines consisting of 30 horizontal dotted lines.



A series of horizontal dotted lines for writing notes, spanning the width of the page.

